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ABSTRACT

During the spring of 1982, over 80,000 students and nearly 2,000 teachers in British Columbia participated in the 1982 Science Assessment, contributing toward understanding of the status and progress of science education in the elementary and secondary schools of the province. The assessment was the second in science, the first occurring in 1978. This general report is divided into eight sections. Following an introduction (chapter 1), the development, piloting, and selection of items for the final achievement and attitude/opinion measures used in the assessment are discussed in chapter 2. Chapters 3-5 contain interpretations of the grade 4, grade 8, and grade 10-12 results, focusing on: (1) student characteristics; (2) achievement in science processes, knowledge (recall and understanding), and higher level thinking; (3) overall achievement results; (4) comparisons with other grade levels and 1978 survey; (5) achievement of specific sub-groups (including sex and language background); and (6) science interests/attitudes. Chapters 6 and 7 discuss development of elementary/secondary science teacher questionnaires, results, interpretations, and comparisons. Areas addressed include teacher characteristics, training, instruction, materials/equipment, and science programs. The final chapter presents recommendations and conclusions based on total assessment results. Appendices include copies of survey instruments and the provincial results of all questions. (Author/JN)

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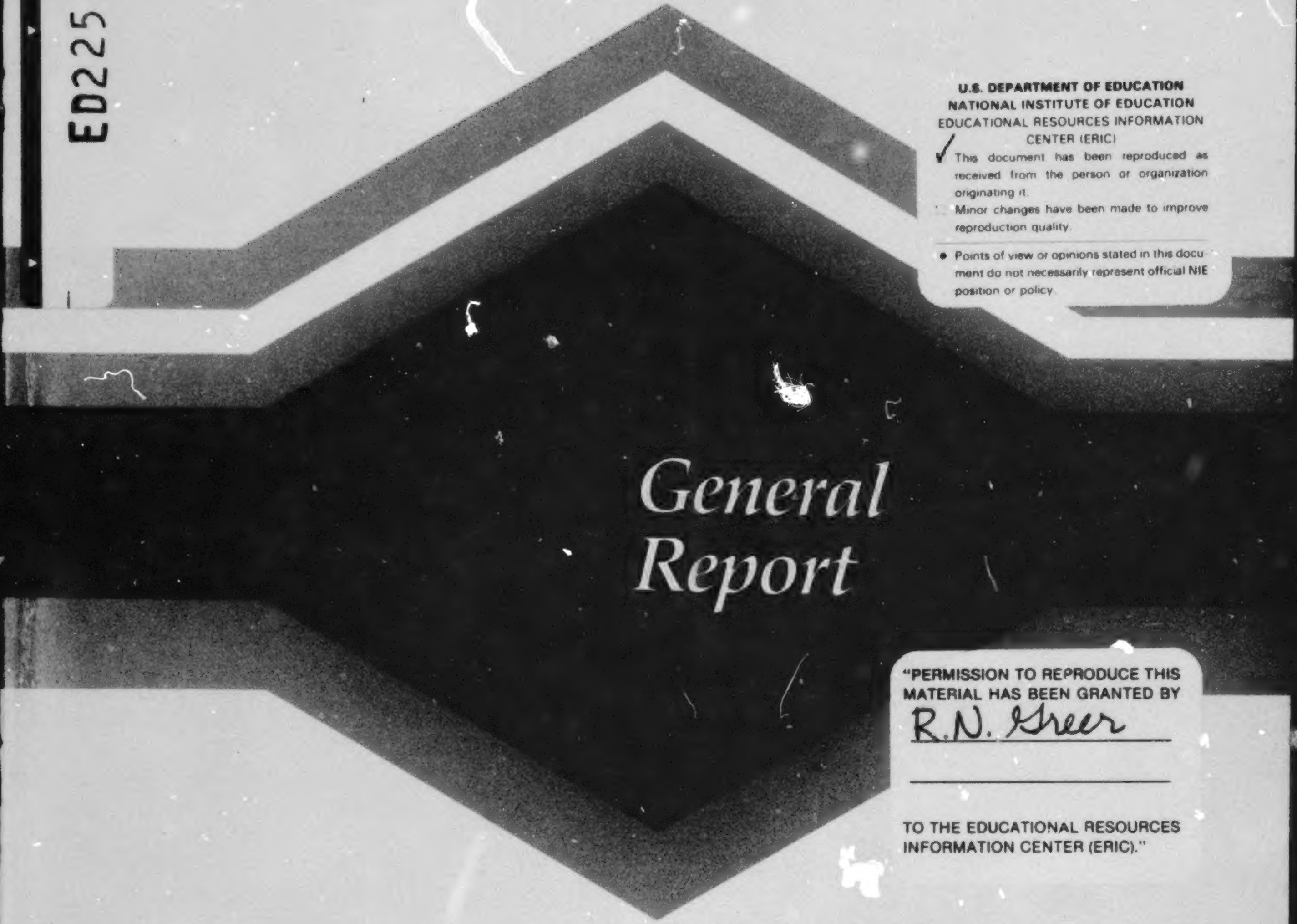

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A REPORT TO
THE MINISTRY OF EDUCATION
PROVINCE OF BRITISH COLUMBIA

The 1982 B.C. Science Assessment

GENERAL REPORT

Hugh Taylor, Editor

Submitted to the
Learning Assessment Branch
Ministry of Education

The Science Assessment Contract Team

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September, 1982

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PREFACE

The Contract Team presents this report on the status of science education in the schools of British columbia with mixed emotions. We are pleased and honored to have participated in the Assessment. We are, in general, less pleased with the findings.

Science - its facts, theories, methods, discoveries and applications - probably has had a greater impact on our lives than any other force in society. According to futurists, we can expect the influence of the sciences to grow at an expotential rate. For example, some scientists suggest that the technology of genetic engineering is the most important biological tool since the microscope. Its use will have profound effects on our moral philosophies.

Further, electronic technologies are developing so fast that it is impossible to plot their growth. Micro-computers are moving into our homes. Word processors are transforming office communication systems, and it is predicted that, within a short time, we will be wearing on our wrists a TV set with built-in watch and calendar.

Governments, at both the provincial and national levels, are appointing science ministers to guide future developments and applications in scientific fields. The British Columbia Government, for instance, includes a Ministry of Science and Technology, a Ministry of Energy, Mines and Petroleum Resources and a Ministry of Environment - all science oriented fields. In addition, the government has created the Science Council of British Columbia for advice on science policy and to award grants to science coordinators.

The media - radio (Quirks and Quarks), television (Nova, What Will They Think of Next?, Nature of Things), magazines (B.C. Discovery, Equinox, Science Digest, Discovery) as well as the daily press - feature current and provocative science topics for the layman.

However, the 1982 Science Assessment results indicate that science education in the public schools of British Columbia has not kept pace with progress and influence of science in society.

It is the hope of the Contract Team that the attention of the Ministry of Education, the universities, the teaching profession, and the public at large will be directed toward overcoming this gap.

Hugh Taylor
for the Contract Team

THE 1982 B.C. SCIENCE ASSESSMENT

Advisory Committee

Albert Haynes (Chairman)	Learning Assessment Branch Ministry of Education
David Bateson	Learning Assessment Branch Ministry of Education
Mary Cooper	Educational Planning & Research B.C. Research
Jack Corbett	Principal Abbotsford School District
Barbara Holmes	Educational Planning & Research B.C. Research
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THE 1982 B.C. SCIENCE ASSESSMENT

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Mary Cooper	Educational Planning & Research B.C. Research
Albert Haynes	Learning Assessment Branch Ministry of Education
Barbara Holmes	Educational Planning & Research B.C. Research
Hugh Taylor	Faculty of Education University of Victoria

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CHAPTER 1

INTRODUCTION

Hugh Taylor

1.1 The Context of the 1982 Science Assessment

During the spring of 1982, over 80 000 students and nearly 2000 teachers in British Columbia participated in the 1982 Science Assessment, contributing toward our understanding of the status and progress of science education in the elementary and secondary schools of the province. The 1982 Science Assessment was the second in the area of science, the first occurring in 1978 (B.C. Science Assessment 1978). This 1982 assessment was part of the continuous cycle of assessments in various subject areas of the school curriculum and was conducted by the Learning Assessment Branch, British Columbia Ministry of Education.

In general, the basic purpose of the various learning assessments is to ensure that important decisions about education are based on reliable and valid current data concerning learning conditions and pupil achievement at both the provincial and the school district levels.

1.2 Terms of Reference for the 1982 Science Assessment

In addition to the general purpose stated above, the 1982 Science Assessment was planned to provide information to persons involved in science education in British Columbia. Therefore, the following aims formed a framework around which the 1982 Science Assessment was designed:

1. Establishment of baseline provincial and school district student achievement data on selected domains rated as priorities in the updated science curriculum guides (1982).

2. Provision of provincial and school district data on changes in student achievement on curriculum guide objectives in selected domains from the 1978 Science Assessment.

3. Development of a bank of B.C. curriculum-related test items for subsequent production of achievement instruments for optional use by classroom teachers as part of their evaluation of students.

4. Documentation of current classroom practices and identification of significant changes since the 1978 assessment.

5. Assessment of the extent to which change has taken place in the non-achievement areas (e.g., facilities, equipment, supplies, attitudes) which were identified as concerns in 1978.

6. Identification of the current context within which science curricula are used.

7. Examination of initial reactions to changes/revisions/updates in science curricula since 1978.

1.3 Organization of the 1982 Science Assessment

1.3.1 Curricular Framework

During the year of the Science Assessment, the British Columbia Ministry of Education introduced the Elementary Science Curriculum Guide Grades 1-7, (1981) into the school system. Also, draft copies of the Junior Secondary Science Curriculum/ Resource Guide were circulated among teachers for their review. These new guides formed the basis for the development of sets of achievement exercises and attitude/opinion questionnaires that were administered to students at the end of the following critical periods in their education: Grade 4, where students were surveyed to determine the level of achievement following the completion of primary education; Grade 8, where students were surveyed to determine the level of achievement following the completion of elementary education; and Grade 12, where students were surveyed to document the level of performance of students who were about to leave public schooling. In addition, the Assessment included a provincial sample of Grade 10 students in order to identify any significant differences which existed between students who were just completing compulsory science education and students who were two years older and who had not taken additional science courses. Chapter 2 contains a detailed description of these various student assessment instruments. The teacher questionnaires described in Chapters 6 and 7 also reflected the contents of the new curriculum guides.

1.3.2 Personnel

The 1982 Science Assessment was basically a cooperative enterprise and included over one hundred individuals from various parts of British Columbia. Nearly all of the participants involved in the planning, development and completion of the assessment were practising science teachers. Names of the participants are listed at the beginning of this report and in Appendices B and C. In general, the assessment was organized in a similar way to the previous assessments conducted by the Learning Assessment Branch in other subjects. As such, the assessment was accomplished through the activities of three major groups: the Learning Assessment Branch, a Contract Team, and a Technical Agency (see Figure 1). The main responsibilities of these groups will be briefly described in the following three sections.

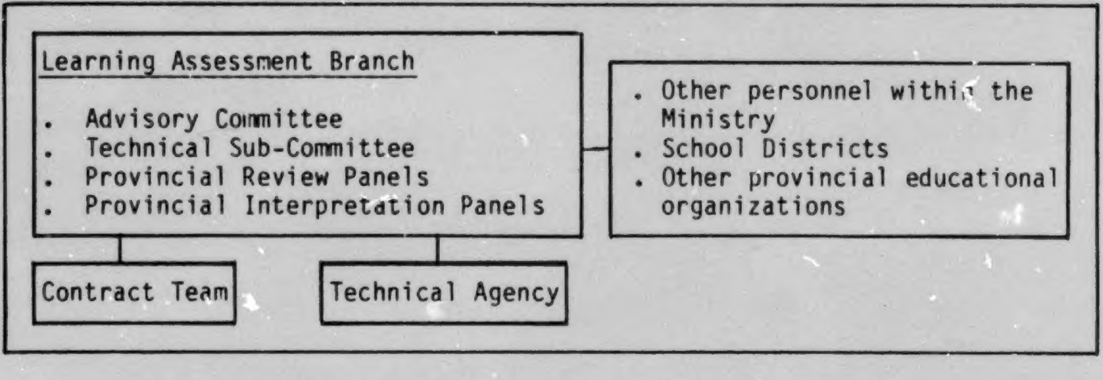

Learning Assessment Branch
. Advisory Committee
. Technical Sub-Committee
. Provincial Review Panels
. Provincial Interpretation Panels
. Other personnel within the Ministry
. School Districts
. Other provincial educational organizations
Contract Team
Technical Agency

Figure 1. Organizational structure of the 1982 Science Assessment

1.3.2.1 Learning Assessment Branch

The Learning Assessment Branch, Ministry of Education, was responsible for, and coordinated, all assessment activities. These included:

- communicating with other personnel within the Ministry, with schools, districts, and other educational organizations during the planning, implementation, and follow-up to the Assessment
- establishing the terms of reference for the Contract Team and Technical Agency and coordinating the selection of these groups
- chairing the Advisory Committee and the Technical Sub-Committee
- arranging and conducting the Provincial Review and Interpretation Panels
- printing all survey instruments and final provincial reports
- preparing and printing district interpretation guides
- coordinating all necessary arrangements with districts and schools for the conduct of the assessments
- preparing, printing, and distributing materials derived from the assessment which are suitable for classroom use
- keypunching all data from final survey forms

1.3.2.2 Contract Team

The Contract Team consisted of three members of the Faculty of Education, University of Victoria and a science teacher from the Greater Victoria School

District. Team personnel were experienced in teaching science at both the elementary and secondary levels and were knowledgeable in the curricular areas assessed. The specific responsibilities of the contract team included:

- designing a table of specifications for the assessment instruments used at grades 4, 8, and 10/12
- developing instruments appropriate for assessing student learning on a province-wide basis, including amplifying curriculum objectives, developing a pool of test items, and generating final achievement forms based on feedback from provincial Review Panels and pilot survey results
- developing items for constructing strands tests at the grade 3/4 and 7/8 levels
- developing instruments suitable for a survey of instructional practices
- preparing contents of instruments for the pilot phase
- participating as resource personnel during the provincial Interpretation Panels
- developing and preparing provincial reports of methods, results, and recommendations, including a Summary Report and a detailed professional General Report

1.3.2.3 Technical Agency

The Technical Agency was responsible for coordinating the distribution, scoring, and analysis of all instruments, and for providing consultative services on an ongoing basis to the Learning Assessment Branch and the Contract Team on matters related to the technical, statistical, and psychometric aspects of the assessment. The Technical Agency consisted of personnel from B.C. Research, a technical operation of the independent, non-profit British Columbia Research Council located on the campus of the University of British Columbia. Specific responsibilities of the Technical Agency included:

- developing selection criteria for building the final survey forms
- printing, packaging, distributing, and collecting instruments for the pilot phase, scoring and analyzing pilot data, providing recommendations for instrument change to the Contract Team and the Learning Assessment Branch

- packaging, distributing, and collecting all final survey forms
- scoring, analyzing, and preparing reports of analyses of final data to the Contract Team and the Learning Assessment Branch
- designing, preparing, printing, and distributing district and independent schools reports of assessment results
- conducting follow-up analyses of a specific nature to identify areas of the province or groups of students requiring assistance
- reporting results to the Ministry of Education

Members of the Technical Agency attended all meetings of the Technical Sub-Committee and the Advisory Committee. These committees are briefly described in the two following sections.

1.3.2.4. Technical Sub-Committee

The Technical Sub-Committee consisted of a technical coordinator from the Learning Assessment Branch who chaired all meetings, the chairman of the Contract Team, a representative of the Technical Agency, and the chairman of the Advisory Committee. The former three members were specialists in educational measurement and evaluation and the sub-committee served as a forum for detailed discussion of issues of a technical, statistical nature and also assumed responsibility for decisions concerning these matters.

1.3.2.5 Advisory Committee

An Advisory Committee, convened by the Ministry of Education, guided the Contract Team by giving advice on the science content under consideration, providing advice for the development of all survey materials and reports, completing detailed analysis and review of all survey materials, chairing the Review Panel and Interpretation Panel meetings, and taking part in follow-up activities as resource personnel for workshops. The members of the Advisory Committee were selected from across the province by the Learning Assessment Branch to reflect a cross-section of opinion on the areas of science being assessed and was composed of:

- practising teachers and administrators
- teacher educators
- a School Board Trustee
- the chairman of the Contract Team

- The Technical Agency representatives
- representatives of the Learning Assessment Branch, one of whom chaired the committee and recorded the proceedings

The eleven members of the Advisory Committee who were selected by the Ministry of Education sat as informed individuals and not as representatives of specific organizations.

As with previous assessments conducted in other curriculum areas by the Learning Assessment Branch, certain groups were created by the assessment process itself. The following two sections describe these very important and influential committees, their functions, and their general composition.

1.3.2.6. Review Panels

In late August, 1981, a series of meetings was held in various parts of British Columbia for the purpose of reviewing materials produced by the Contract Team. Over 50 individuals participated in the various Review Panels (see Appendix B). These panels, chaired by members of the Advisory Committee, were composed of practising teachers/administrators as well as subject matter specialists. Members of the Contract Team acted as observers and consultants at all of the Review Panels.

The main task of the Review Panels was to judge, with the use of specially designed rating scales, all of the potential expanded objectives, achievement survey items, and attitude/opinion/interest statements. Documentation of their ratings and the resultant summaries are on file in the offices of the Learning Assessment Branch. The panel ratings proved valuable to the Contract Team who used them to either omit or revise and improve the quality of the various items prior to their pilot phase.

1.3.2.7 Provincial Interpretation Panels

In early June, 1982, the Ministry of Education convened provincial Interpretation Panels of individuals to evaluate provincial results for each level of the science program assessed.

Panelists received, in advance of their first meeting, a copy of the table of specifications and a copy of the achievement items classified in terms of learning objectives. Prior to the first session, panelists were asked to complete the items and, for each item, set percentage figures for "acceptable" and "desirable" levels of performance for the province as a whole, based on the percentage of students they felt should be able to correctly answer each item.

At their first session, panelists were given copies of the Spring 1982 provincial results for each item in terms of the proportion of students who answered the item correctly (p-value). They were then asked to individually rate the performances by comparing the results with their previously estimated acceptable and desirable levels. Ratings were made on a five-point scale from "weak" to "strong". These ratings were discussed in small groups and then in one large group in an attempt to reach consensus. Both consensus and minority views were recorded.

At a final session, groups of panelists were asked to develop ratings (on the same five-point scale) for each of the domains assessed and to contribute interpretive comments and recommendations in light of the provincial performances.

Members of the Advisory Committee chaired the various panels and recorded the final ratings along with minority views and comments. Members of the Contract Team were present at the Interpretation Panel meetings where they acted as observers and consultants, and also collected summaries of the ratings and comments for inclusion in the present report (see Chapters 3-5).

Interpretation Panels (see Appendix C) were composed of:

- practising teachers/administrators from all levels of the education system
- teacher educators
- individuals from interested and informed groups
- trustees
- parents
- members of the public

1.4 Organization of the Report

Chapter 2 deals with the development, piloting, and selection of items for the final achievement and attitude/opinion measures. Chapters 3-5 contain interpretations of the grade 4, 8, and 10/12 results. Chapters 6 and 7 are concerned with the development of the science teacher questionnaires, the questionnaire results, and with various interpretations and comparisons. The final chapter presents some recommendations and conclusions based on the findings of the total assessment results. The appendices list the various personnel involved in the assessment and also include copies of all survey instruments along with a record of the provincial results for all questions.

CHAPTER 2

DEVELOPMENT AND DESCRIPTION OF STUDENT ASSESSMENT INSTRUMENTS

Hugh Taylor

This chapter is composed of three parts. The first describes the general approach used in designing, developing, and selecting items for the pilot and final achievement surveys at all grade levels. The second part describes the unique and common characteristics of the various achievement forms at each of the three main grade levels assessed. The final part describes the design and development of the various attitude/opinion scales used at different grade levels.

2.1 Development of the Achievement Survey Instruments

The development of the student achievement surveys consisted of the following phases: identification of appropriate domains, objectives, and amplified objectives; selection and/or construction of appropriate items to measure the amplified objectives; piloting the items; and choosing items for the final provincial forms.

2.1.1 Domains and Objectives

In developing all achievement items and affective statements, care was taken to ensure that they were related to important aspects of the British Columbia elementary science and junior secondary science curriculum guides. The Contract Team therefore chose to name the domains so that they would parallel the following four paraphrased main goals contained in both the elementary and proposed junior secondary curriculum guides:

The School Science Program should develop in students:
Goal A--appropriate science attitudes
Goal B--the processes and skills of science
Goal C--scientific knowledge
Goal D--creative, rational, and critical thinking

A domain, in the context of this Assessment, is an area of science learning for which achievement items were written and categorized for reporting purposes. In the 1982 Science Assessment, three achievement domains were used and defined at all grade levels as follows:

Domain 1--Science Processes	processes such as observing, classifying, and interpreting information for the purpose of solving problems.
Domain 2--Knowledge--recall and understand	ability to recall and understand various science facts, concepts, and principles including safety procedures.

Domain 3--Higher Level Thinking	ability to solve problems by transferring prior knowledge and/or learned behavior (including science processes) to new situations.

Within these domains, various achievement items were grouped in terms of objectives. An objective, in the context of this Assessment, is a sub-division of a domain containing similar types of items (similar in content or intellectual processes) which can be scored and used conveniently for reporting purposes. Table 2.1 shows the relationship between domains and objectives at various grade levels. Domains, objectives and sample items at different grade levels are presented in Chapters 3-5.

Expanded objectives which guided the item choice or construction, particularly at the elementary school level, were based on a careful review of the relevant teaching materials. Also, in Domain 1--Science Processes, a selection for assessment had to be made from the 12 "processes" listed in the curriculum guides. The decision to assess a particular process was based on such factors as:

- the amenability of the process to be assessed using multiple-choice format
- the perceived emphasis the process should have at the grade level being assessed
- the appropriateness of assessing the process at two or more grade levels
- whether or not the 1978 Science Assessment contained process items that could be used to measure achievement change

2.1.2 Item Development

The development of the achievement instruments involved many people who devoted a considerable number of hours to creating, studying, analyzing and criticizing hundreds of items. The primary responsibility for developing the items rested with members of the Contract Team who worked on the task during the late spring and summer of 1981. John Sheppy headed up the work at the Grade 4 and Grade 8 levels and David Stronck was responsible for developing items at the Grade 12 level. Robert Hunt wrote items at all grade levels and Hugh Taylor, working with the Technical Sub-Committee, acted as general item editor.

2.1.3 General Principles Used for Item Preparation

All achievement items developed for the Assessment were of the multiple-choice type. At Grades 8 and 12, the modal number of response options was five--the correct answer, three distractors, and an "I don't know" option. However, at Grade 4, approximately one-third of the items had only two distrators. The

Table 2.1: Domains and Objectives

Domains	Objectives		
	Grade 4	Grade 8	Grade 12
1. Science Processes	● Observe and Infer		
	● Quantify		
	● Classify	● Classify	
	● Communicate	● Communicate	
		● Interpret Data	● Interpret Data
		● Identify and Control Variables	● Identify and Control Variables
2. Knowledge--recall and understand	● Biological, Physical and Earth/Space Science Concepts	● Biological, Physical and Earth/Space Science Concepts	● Major Concepts, Basic Principles, Laws and Supporting Facts of Science
	● Applications of Science (Technology) and the Nature of Science	● Applications of Science (Technology) and the Nature of Science	● Applications of Science (Technology) and the Nature of Science
	● Safety Procedures	● Safety Procedures	● Safety Procedures
3. Higher Level Thinking	● Apply Biological, Physical and Earth/Space Science Concepts	● Apply Biological, Physical and Earth/Space Science Concepts	● Evaluate Evidence for Conclusions
	● Use Rational and Critical Thinking	● Use Rational and Critical Thinking	● Solve Abstract Problems

number of options at the Grade 4 level was adopted for two reasons. First, it was felt that the limited experience of the typical Grade 4 student in responding to multiple-choice items would not bias the results if the number of option choices were reduced to three. Second, it was hoped that the reading time per item would be reduced with a resultant increase in the number of possible items assigned to each form.

At the Grade 4 level, careful attention was also given to the reading difficulty level of the words used in the items. Dr. Jean Dey, a primary specialist in the Faculty of Education, University of Victoria, analyzed all items and either approved them, or recommended changes so that the wording would be at an appropriate reading level for Grade 3 students, one grade below the level of administration.

Other important differences occurred in the current achievement survey forms at the Grade 4 level compared with those of the 1978 Science Assessment. In 1978, all of the stems of the 68 items, but none of the options, were read aloud by the teacher supervisor administering the instrument. Also, the 1978 items were administered during two periods of approximately 35 minutes each. However, in the 1982 Assessment, with random assignment of the three forms within each classroom, a total of 108 items was completed in approximately 35 minutes with students reading all parts of the entire group of items.

2.1.4 Sources Used for Developing Items

In general, the items used during the 1982 Science Assessment were designed by members of the Contract Team specifically to measure important goals stated in the British Columbia science curriculum guides.

During its initial period of item development, the Contract Team studied a variety of sources containing science items. The sources listed in Tables 2.2 to 2.5 proved helpful, particularly in suggesting various types of item format designs.

Table 2.2: Item Sources: General

British Columbia Science Assessment, 1978.

Dressel, P.L. and Nelson, C.H. Questions and Problems in Science. Educational Testing Service, 1956.

National Assessment of Educational Progress, Science Assessment, 1969, 1972 and 1976.

Manitoba Science Assessment Program, 1980.

Table 2.3: Item Sources: Primary

Standardized Test	Year	Form	Level	Grade
Stanford	1973	A	Prim II	2.5-3.4
	1973	A	Prim III	3.5-4.4
Metropolitan	1978	JS	Prim I	1.5-2.4
	1978	JS	Prim II	2.5-3.4
	1978	JS	Elem	3.5-4.9
Comprehensive Test of Basic Skills	1973	S	1	2.5-4.9
Sequential Test of Educational Progress(STEP)	1957	A	4	4-6
Metropolitan	1959	A	4	7-9

Table 2.4: Item Sources: Intermediate

Standardized Test	Year	Form	Level	Grade
STEP II	1969	F	4	3-6
			3	6-9
Metropolitan	1970	F	Inter	5-6
Stanford	1972	A	Prim III	3-4
	1973	A	Inter I	4.5-5.4
	1973	A	Inter II	5.5-6.9
Metropolitan	1978	JS	Inter	5.0-6.9
Comprehensive Test of Basic Skills	1973	S	2	4.5-6.9
	1973	S	3	6.5-8.9

Table 2.5: Item Sources: Secondary

Standardized Test	Year	Form	Level	Grade
Sequential Test of Educational Progress	1956		2	4.5-6.9
			1	13-14
STEP Series II	1969	A	2	9-12
			1	13-14
Stanford	1964	X	Advanced	
Metropolitan	1970		Test 2	
Stanford	1973	A	Advanced	7-9.5
Iowa Tests of Educational Development	1960		Test 2	
			Test 6	
Comprehensive Assessment Program	1980	Biology		9-12
		Physical Science		9-12
Metropolitan	1978	JS	Advanced I	7.0-9.9
Content Evaluation Series	1969	1	Physical	8-9
	1969	1	Earth	8-9
Comprehensive Test of Basic Skills	1973	S	4	8.5-12.9

2.1.5 Role of the Review Panels in Selecting Objectives and Items

Achievement survey design, including the writing of objectives and items, was one of the main tasks of the Contract Team during the summer of 1981. Over 900 items and their amplified objectives were forwarded to the Advisory Committee for study and criticism. Based upon the Advisory Committee's suggestions, the Contract Team extensively revised objectives and items, and presented them to members of various Review Panels for their professional criticism in late August, 1981. One panel for each of the three grades assessed was held in Richmond. Within the same week, a Primary Panel (grade 4 items) met in Cranbrook, an Intermediate Panel (grade 8 items) in Parksville, and a Secondary Panel (grade 10/12 items) in Kelowna. A total of 53 science teachers took part in the review process (see Appendix C).

The two main tasks of the Review Panels were to rate all the expanded objectives and to rate the appropriateness of the items for measuring the objectives. Specially designed rating sheets were constructed that allowed expanded objectives and items to be rated within their appropriate domains. Both objectives and items were rated on a three-point scale:

G = Good
U = Usable
N = No, do not use.

Very few objectives were rated "N". However, many objectives and items were improved through Review Panel suggestions, especially regarding the clarity and preciseness of the wording.

Table 2.6 shows how the total number of items developed by the Contract Team changed during the achievement survey test development process. One notes from Step 3 of the table that of 880 items initially presented a total of 526 survived the first phase of review (Step 2). After piloting the items, 387 remained (the sum of the totals in Rows 5 and 6) and were then used for the production of the achievement surveys and subsequent production of the final strands tests. This reduction is a typical result of the item evaluation process in test development and, in general, results in a set of high quality items. It must be pointed out however, particularly by the authors of this report, that they have never seen a test in which improvements could not be made to certain items and, after the fact, one can conclude that of the current assessment forms.

After the items had been piloted, the Technical Sub-Committee checked each item in terms of its correlation with:

- the appropriate objective score
- the appropriate domain score
- other domain scores

Items were either modified, or deleted from the final assessment forms, because of factors such as:

- p-values greater than .95 or less than .20
- correct-answer-to-sub-test point-biserial correlation coefficient less than .20
- distractor-to-sub-test point-biserial correlation coefficient greater than .10
- distractors with p-values less than .01
- omissions and/or multiple response greater than .05

Table 2.5: Number of Items at Various Steps in the Item Development Process

	Grade			
Activity	4	8	12	Total
1. Total Bank of Items Presented to the Review Panels (August 1981)	342	402	136	880
2. Items Removed by the Review Panels and/or Technical Sub-Committee (September 1981)	114	176	64	354
3. Items Selected for Piloting (October 1981)	228	226	72	526
4. Items Removed after Piloting	60	50	29	139
5. Items Selected for the Future Strands Tests	80	80	0	160
6. Items Selected for the Achievement Surveys	88	96	43	227
7. 1978 Items Used in the 1982 Surveys	20	24	27	71
8. Total Items Used on the Achievement Surveys	108	120	70	298

2.1.6 Description of Student Samples and Reporting Categories

2.1.6.1 Sampling

B.C. Research, the Technical Agency for the 1982 Science Assessment, was responsible for planning the details of sampling students for both the pilot and final phases of the Assessment. The sampling plan had to encompass the following policy constraints developed over the years by the Learning Assessment Branch:

1. A class of students, which was the basic unit of sampling, could not participate in more than one activity for a large scale assessment project in any one school year.

   In practice, this meant that an individual student could spend no more than approximately 45 minutes in (i) the pilot phase or (ii) the main assessment phase or (iii) the strands tests development phase of the assessment activities. The purpose of this policy is to minimize the amount of time a student spends in assessment activities.

2. Within a school district, if sampling was to be used, then enough students should complete the survey forms so that when the data were interpreted, one could be quite confident that the resulting statistics were very close to the values one would expect to obtain if all of the students in the district had taken part in the assessment in March.

Technically, the standard that was used for developing a sampling plan within a district ensured that enough students were tested so that the population estimates derived from the sample statistics would be correct within five percentage points (the "margin of error" or "limit of accuracy") 95 percent of the time (the "probability" or "confidence level").

In most cases, the main statistic used for interpreting the achievement survey was the p-value of an item, objective, or domain. The p-value of an item refers to the percentage of students attempting the item who choose the correct response. Objective and domain scores were interpreted as the mean-percent-correct.

As a result of the above constraints, out of the 75 school districts in British Columbia, 63 districts required full participation of all schools in the main Assessment (March, 1982) and were therefore not available for sampling or for participation in the pilot phase of the Assessment. In the remaining 12 districts, care was needed to ensure that if schools or classes were used in the pilot phase, then there had to be retained a sufficient number of students for participation in the main Assessment to ensure stable district statistics. As a result of the foregoing factors, the following number of students took part in the pilot phase of the assessment:

Grade 4 - 2646
Grade 8 - 2996
Grade 10 - 85
Grade 12 - 376

In addition, a final timing pilot was conducted at Grade 4 in six schools in the lower mainland of British Columbia.

The larger pilot sample totals in Grades 4 and 8 were due mainly to the larger number of pilot forms used within a class in order to calibrate the items for strands tests which will be used in the future to measure achievement within the elementary science curriculum. A secondary factor was that the Grade 12 survey, limited to two forms, required fewer achievement items than the survey forms for the other grades. A list of the pilot schools is included in Appendix D. In the main Assessment (March, 1982), all schools were included at all three grade levels (4, 8, and 12) in 63 school districts. At grade 10, a representative sample of 85 classes (approximately 2000 students) was drawn. This Grade 10 sample was used to identify any significant achievement differences between students who were just completing compulsory science education (Science 10) and students who were two years older and who had not taken additional science courses.

The procedure for sampling Grade 10 students was:

- within a geographic zone, sampling was proportional to zone size
- within a geographic zone, schools were randomly ordered by grade enrollment and stratified such that each stratum should, in terms of enrollment, yield two or three classes
- within a stratum, the two or three classes were chosen systematically from a random start
- within a school, classes were chosen according to the instructions given the principal

2.1.6.2 Reporting Categories

At the beginning of each survey booklet, students were asked to provide certain background information (see Appendices E to G). This information provided potential variables for reporting achievement data. Table 2.7 lists the variables included in the various grade booklets. Chapters 3-5 interpret achievement results in terms of some of these variables.

Overall, 29 741 Grade 4, 32 775 Grade 8 and 27 438 Grade 12 students wrote the final forms of the 1982 Science Assessment.

Table 2.7: Student Background Variables

Variable	Grade		
	4	8	12
Age	X*	X	X
Sex	X	X	X
First Language Learned	X	X	X
Home Language Now	X	X	X
Place of School Attendance in			
Grade 4		X	
Grade 8			X
Science courses completed		X	X
Method of scheduling science courses		X	
Science courses currently enrolled in			X
Post Secondary plans			X

* X = inclusion of variable on student achievement forms

2.2 Characteristics of the Achievement Survey Instruments

2.2.1 Grade 4 Table of Specifications

The three Grade 4 survey forms (X, Y, and Z) contain a total of 108 items, 36 on each form. The forms have an approximately equal number of items from the various domains and objectives. Appendix E identifies each item on each form in relationship to its domain and expanded objective.

Table 2.8 shows how the items used for the Assessment were distributed in terms of science content and intellectual levels. The vertical axis shows the science content categories and the horizontal axis shows the intellectual behaviors sampled by the items. Note that the intellectual behavior categories are also used to define the domains and objectives.

TABLE 2.8

TABLE OF SPECIFICATIONS FOR THE GRADE 4 SCIENCE ASSESSMENT

Domain Objective	Science Processes				Knowledge	Higher Level Thinking		
	Observe and Infer	Classify	Communicate	Quantify	Recall and Understand	Apply Concepts	Use Critical and Rational Thinking	
Physical Science	18	18	18	6	6	3	6	
Biological Science					6	3		
Earth/Space Science					6	3		
Applications of Science (Technology)					3			
Nature of Science					3			
Safety Procedures					9			
Number of Items	18	18	18	6	33	9	6	108
Percentage of Items (Objectives)	17	17	17	5	31	8	5	
Percentage of Items (Domains)	56				31	13		

The inner cells of the table list the total number of items on the Assessment forms that measured the various behaviors and science content. The lower cells show the number of items within each objective and the percentage of items within each objective and domain. Note that over one-half the items measured the students' ability to use science processes, while 31 percent and 13 percent respectively measured science knowledge and higher level thinking.

2.2.2 Grade 8 Table of Specifications

The three Grade 8 survey forms (X,Y, and Z) contain a total of 120 items, 40 on each form. The forms have an approximately equal number of items from the various domains and objectives. Appendix F identifies each item on each form in relationship to its domain and objective.

The vertical axis on Table 2.9 shows how the items used for the Assessment were distributed in terms of science content categories and the horizontal axis shows the intellectual behaviors sampled by the items. Note that the intellectual behavior categories are also used to define the domains and objectives.

The inner cells of the table list the total number of items on the Assessment forms that measured the various behaviors and science content. The lower cells show the number of items within each objective and the percentage of items within each objective and domain. Note that approximately one-half the items measured the students' ability to recall science knowledge, while 30 percent and 22 percent respectively measured science processes and higher level thinking.

Of the 120 items, nine dealing with science processes and 15 measuring science knowledge were repeat items from the 1978 British Columbia Science Assessment. The identification and special interpretation of these items are included in Chapter 4.

2.2.3 Grade 12 Table of Specifications

The two Grade 12 survey forms (X and Y) contain a total of 70 items, 35 on each form. The forms have an approximately equal number of items from the various domains and objectives. Appendix G identifies each item on each form in relationship to its domain and objective.

Table 2.10 shows how the items used for the Assessment were distributed in terms of science content and intellectual levels. The vertical axis shows the science content categories and the horizontal axis shows the intellectual behaviors sampled by the items. Note that the intellectual behavior categories are also used to define the domains and objectives.

TABLE 2.9

TABLE OF SPECIFICATIONS FOR THE GRADE 8 SCIENCE ASSESSMENT

Domain / Objective	Science Processes				Knowledge	Higher Level Thinking		
	Classify	Communicate	Interpret Data	Identify and Control Variables	Recall and Understand	Apply Concepts	Use Critical and Rational Thinking	
Physical Science	9	9	9	9	12	6	12	
Biological Science					12	6		
Earth/Space Science					9	3		
Applications of Science (Technology)					6			
Nature of Science					6			
Safe Laboratory Procedures					12			
Number of Items	9	9	9	9	57	15	12	120
Percentage of Items (Objectives)	7.5	7.5	7.5	7.5	48	12	10	
Percentage of Items (Domains)	30				48	22		

TABLE 2.10

TABLE OF SPECIFICATIONS FOR THE GRADE 12 SCIENCE ASSESSMENT

Domain / Objective	Science Processes		Knowledge	Higher Level Thinking		
	Interpret Data	Identify and Control Variables	Recall and Understand	Evaluate Evidence for Conclusions	Solve Abstract Problems	
Chemistry	10	12	3	6	3	
Physics			4		3	
Biological Science			5		3	
Earth/Space Science			4		3	
Applications of Science (Technology) Nature of Science			6			
Safe Laboratory Procedures			8			
Number of Items	10	12	30	6	12	70
Percentage of Items (Objectives)	14	17	43	9	17	
Percentage of Items (Domains)	31		43	26		

The inner cells of the table list the total number of items on the Assessment forms that measured the various behaviours and science content. The lower cells show the number of items within each objective and the percentage of items within each objective and domain. Note that 30 percent of the items measured the students' ability to use science processes, while 43 percent and 27 percent respectively measured science knowledge and higher level thinking.

Of the 70 items, 12 dealing with higher level thinking and 15 measuring science knowledge were repeat items from the 1978 British Columbia Science Assessment. The identification and special interpretation of these items are included in Chapter 5.

2.2.4 Reliability and Validity Standards

Based on experience with past assessments conducted by the Learning Assessment Branch, a minimum of six items at an objective level and at least 12 items at the domain level were required in order to ensure an appropriate degree of internal-consistency reliablity. In most of the objectives and domains used in the 1982 Science Assessment, the number of items assigned within the various sections of the final achievement forms totalled well above the required minimum. The latter conditions, along with careful item editing to ensure relative homogeneity of content and intellectual process, resulted in the reliablility coefficients (alpha) shown in Table 2.11. Note that the coefficients range from a low of .38 to a high of .73. The median reliability over all domains and grades is .62.

Reliability values are generally related to the number of items used within domains at each grade level, and the latter varied mainly as a function of the number of achievement forms used. At the Grade 4 level, 108 items were distributed equally over three forms. At the Grade 8 level, 120 items were distributed equally over three forms and, at the Grade 12 level, 70 items were distributed equally over the two forms. Tables printed in Appendices E to G show the organization of test items into domains and objectives, and their specific assignment to various achievement booklet forms.

Evidence of the curricular validity of all amplified objectives and items was gathered by submitting them to science specialists at various Review Panels held during late August, 1981. The judgemental process used by panel members is explained in Section 2.1.5. However, in all cases, only objectives and items on which there was total judgemental agreement were used during the pilot phase of the Assessment.

Table 2.11: Internal Consistency Reliability* by Domain, Grade, and Form

Domain	Grade							
	4			8			12	
Form	X	Y	Z	X	Y	Z	X	Y
Number of Students	994	993	991	1049	1050	1045	1158	1158
Science Processes	71(20)	73(20)	69(20)	61(12)	62(12)	64(12)	67(11)	67(11)
Knowledge	58(11)	50(11)	62(11)	65(19)	73(19)	59(19)	70(17)	62(13)
Higher Level Thinking	38(5)	48(5)	43(5)	43(9)	44(9)	53(9)	52(7)	64(11)
Booklet (total score)	81(36)	81(36)	82(36)	80(40)	83(40)	79(40)	84(35)	84(35)

* decimals have been omitted, number of items in parentheses

2.3 Attitude/Opinion/Interest Survey Instruments

2.3.1 Introduction

The British Columbia curriculum guides for both elementary and junior secondary school science advocate the development of positive science attitudes. The general attitudinal goals in the guides are stated and expanded upon as follows:

The Elementary School Science Program should develop in students appropriate science attitudes.

The student should demonstrate

- awareness and appreciation of science, and interest in science and its relationship to the world and the future
- curiosity - to question and to persevere in seeking solutions
- adaptability in a changing world - a willingness to expect and accept scientific change.

The Junior Secondary Science Program should provide opportunities for students to develop positive science attitudes.

Opportunities should be provided to

- develop curiosity about and interest in trying to understand natural events
- show how science can be helpful in solving many everyday problems
- discuss how scientific endeavour is important to our society
- foster an appreciation of the impact of technology on the world
- develop a more responsible attitude towards self and society through the examination of social and environmental issues
- use scientific knowledge and skills to help clarify personal values and beliefs
- discuss some science-related activities which could be done during leisure time
- gain an appreciation of the benefits and responsibilities of working cooperatively as well as independently
- develop a concern for safety
- deal with problems in an open minded manner.

With the above goals forming a general orientation, the development of affective items was made by attempting three approaches: (1) direct use of statements from the curriculum guides, (2) use of items from the 1978 Assessment, and (3) use, or revision, of items found in the literature.

The first approach to determine attitudes that could be measured at the elementary level was to identify all statements in the Elementary Science Curriculum Guide related to objectives in the affective domain. The following are typical of the many learning outcomes listed:

- express a willingness to question, handle materials, and collect materials
- demonstrate curiosity and persistence
- appreciate the amount of science involved in commonplace things such as candles
- develop an appreciation for the interrelationship of art and science

- develop an appreciation that science is involved in most everyday things

Unfortunately, because of their very general nature, the statements in the curriculum guide provided minimal help in developing an instrument to measure science attitudes.

A second approach was based on a study of the attitude/opinion/interest instruments developed for the 1978 British Columbia Science Assessment. The major difficulties in replicating the 1978 design were first, the difference in the time permitted for affective assessment in 1978 compared with that permitted in 1982 and second, the differences in the populations sampled by the two assessments. In 1978, approximately 35 minutes were allowed for students to respond to over 100 attitude/opinion/interest statements. However, in 1982, a new Learning Assessment Branch policy, based upon experience with recent provincial assessments, permitted a maximum of only five minutes for affective measurement within the total assessment time of 45 minutes per student. Also, the provincial samples used in 1978 were students from grades 7, 9, and 11 whereas the 1982 samples were from grades 4, 8 and 12. These factors ruled out a replication of the 1978 design. However, a number of affective statements from the 1978 Assessment were used in 1982. The statements were mainly from the areas of interest in science as a career, attitudes toward scientists and attitudes toward the methods of science.

A third approach which proved very helpful in planning the affective component of the 1982 Science Assessment was based on a review of science education literature related to affective measurement. Over 50 articles published during the 1970s were reviewed. The following sources were of particular value in conceptualizing the field of affective measurement in science: Fraser, 1977; Gardner, 1975a; Gardner, 1975b; Gauld and Jukins, 1980; Klopfer, 1976; Munby, 1980; and Ormerod and Duckworth, 1975. The interested reader should consult the foregoing sources for valuable background information on the myriad problems associated with affective measurement in science education.

In view of the preceding factors, and after extensive consultation with the Technical Sub-Committee, the Advisory Committee, and the various Review Panels, it was decided to pilot a number of affective scales in October, 1981, using a matrix sampling design.

2.3.2 Description of and Rationale for the Affective Instruments

Table 2.12 presents a brief description, and rationale for, the attitude/opinion/interest instruments used during the pilot study. Also included in the table are examples of both positive and negative statements used in the various assessment instruments.

Table 2.12: Affective Instruments

Attitudinal Target or Opinion/ Interest Area	Description / Rationale
School Science	Statements were designed to assess students' generalized affect toward science as a school subject. Care was taken to eliminate references to important but perhaps too specific types of activities that may have confounded the interpretation of the scale. Therefore, activities such as enjoying science laboratory work, going on science field trips, or taking pride in doing careful work in science were not considered appropriate references to assess in a general scale designed to measure science as an interesting and valuable school subject. The following statements are examples of items included in the scale: ● I like to study science in school. ● I do not enjoy science.
Science Careers	An attempt was made to develop an instrument that would measure students' general willingness to enter a career in the field of science. Imbedded in the scale were three statements that measured sex-related differences in attitude toward the desirability of a career in science. These latter items were not considered in the summative ratings and were therefore interpreted individually. The following are examples of statements used in the scale: ● A career in science would be very satisfying. ● Scientific work does not interest me.
Scientists	Scientists, of course, differ as much in their abilities and personal characteristics as do members of any other professional group in society. Therefore, as a concept, "Scientists" cannot be considered unique and one would expect to encounter great difficulty in developing a unidimensional scale. However, considering this limitation, it was decided to repeat some of the statements from the 1978 B.C. Science Assessment and attempt to develop a scale related to students' generalized affective reactions to scientists. The following are examples of statements contained in the scale: ● Scientists have been very helpful to mankind. ● Scientists are usually odd compared with most people I know.
Science and Society	Originally, during the piloting stage of the assessment this set of items was entitled Science as an Enterprise. However, it was re-named Science and Society after an analysis of the

Attitudinal Target or Opinion/ Interest Area	Description / Rationale
	pilot results. The new title seemed more descriptive of the statements that were chosen for the final instrument. The scale attempts to measure a broad area that includes the interrelationships and interdependencies of science, technology, and society. The following are examples of statements contained in the scale: ● Scientific progress and the progress of man go together. ● Science is not important in everyday life.
Methods of Science	Literature in science education shows that the attitudinal target entitled Methods of Science is extremely complex. As such, this scale assesses a variety of cognitive and affective components related to scientific knowledge, the processes of scientific inquiry, and the nature of scientific inquiry. In view of the fact that over one-half of the items on the pilot questionnaires had very low, or negative, corrected item-total correlations at the grade 8 level it was decided to restrict the use of the scale to the grade 10/12 level. The following are examples of statements contained in the scale: ● Science is getting closer and closer to the truth. ● When traditional beliefs are in conflict with scientific discoveries, it is better to accept traditional beliefs.
Interest in Science Topics	Three topics were chosen in each of the physical science, biological science, earth/space science, and technology areas for students in grades 4 and 8 to respond to in terms of how interested they were in learning about the topic. Different topics based on the content of the elementary and junior secondary science curriculum guides were used at the two grade levels. The following are examples of topics presented: Grade 4 - How animals live. — Biological - The moon and stars. — Earth/Space Grade 8 - Chemicals in foods. — Physical - How computers work. — Technology
Specific Issues	This group of items dealt with students' opinions in areas such as conservation, pollution, animal experimentation, creation of life, and the use of herbicides/insecticides. Ten equivalent statements were used at both the grade 8 and the grade 10/12 levels. All items were analysed individually. Some statements had conditions attached to them in order to make interpretation more precise. The following are examples of such statements:

- Factories should be required to reduce smoke pollution even if prices go up.
- Scientists should conduct experiments on animals if they think people will be helped.

2.3.3 Guidelines Used in Affective Scale Construction

In developing the affective instruments, the following guidelines formed the basis for the scale construction and item selection:

Likert Scale. All scales were constructed using the popular Likert process whereby students place themselves on an attitude continuum for each positively worded statement running from "Strongly Agree" (5) through "Agree" (4), "Can't Decide" (3), "Disagree" (2) to "Strongly Disagree" (1). For unfavorably worded statements, the weights given to the response categories are reversed, so that high total scores (the sum of the individually weighted responses) may be interpreted to reflect a positive student attitude toward the particular area measured.

Criteria for writing affective statements. In general, Edward's (1957) list of criteria recommended in the writing of affective statements was used as a guide. Edward's criteria are:

1. Avoid statements that refer to the past.
2. Avoid statements that are factual or capable of being interpreted as factual.
3. Avoid statements that may be interpreted in more than one way.
4. Avoid statements that are irrelevant to the psychological object under consideration.
5. Avoid statements that are likely to be endorsed by almost everyone or by almost no one.
6. Select statements that are believed to cover the entire range of the affective scale of interest.
7. Keep the language of the statements simple, clear and direct.
8. Statements should be short, rarely exceeding 20 words.
9. Each statement should contain only one complete thought.
10. Statements containing universals such as all, always, none, and never often introduce ambiguity and should be avoided.
11. Words such as only, just, merely and others of a similar nature should be used with care and moderation in writing statements.
12. Whenever possible, statements should be in the form of simple sentences rather than in the form of compound or complex sentences.

13. Avoid the use of words that may not be understood by those who are to be given the completed scale.
14. Avoid the use of double negatives. (pages 13-14)

Homogeneity of the affective construct. All statements within each scale attempted to express a general positive or negative emotional reaction toward a relatively unique attitudinal object. As such, each statement on a scale was assumed to measure the same internal emotional state of the responding student. The measure of the usefulness of each item to this process was estimated by the correlation of the item with the total score on the scale, after the latter had been corrected by eliminating the contribution of the item under study. In general, corrected-item total correlations were quite high. However, approximately one-quarter of the original statements were deleted from the final scales at the secondary level in order to reduce total testing time while still preserving a satisfactory level of internal-consistency reliability.

2.3.4 The 1982 Affective Questionnaires

In the fall of 1982, a total of 122 statements were piloted over the three grade levels assessed. Each of the items was then re-analysed in terms of the guidelines listed in 2.3.3 above. As a result, approximately one-third of the items were eliminated and the remainder were used for the final affective scales.

Table 2.13 shows a listing of the final affective scales, their lengths and where they were placed in the various grade level assessment forms. It also presents statistical information derived from a random sample of ten percent of the provincial population at each of the grade levels assessed. Note that two affective scales were placed on each of the Grade 12 forms. At the Grade 4 level, the School Science scale was placed on each form, and four of the twelve Interest in Science Topics items were placed on each of the three forms.

As seen in Table 2.13 the Hoyt reliability estimates are all at an appropriate level for judging group differences in attitudes. The only scale that has weak measurement characteristics is Methods of Science. A study of its items showed that the scale carries a large cognitive component, and, as such, might be interpreted more appropriately in terms of its individual items rather than its total score.

A variety of approaches may be used for interpreting affective scores. In the Affective Results sections of Chapters 3-5, affective data are interpreted using the theoretical mid-point of the scale. The mid-point of the scale allows one to interpret the data in terms of the number of pupils who scored above or below the theoretical mid-point of the scale. It is a simple method which allows one to interpret scores below the mid-point as expressing negative affect while those above the mid-point are assumed to express positive affect toward the attitudinal object.

Table 2.13: Statistical Data Related to the Affective Instruments

Affective Scales	Grade	Form	Number of Items	Sample Sizes	Mean	Standard Deviation	Relia-bility	Standard Error of Measurement
School Science	4	X,Y,Z	7	2978	25.7	6.0	.86	2.1
	8	Y	10	1050	34.9	7.3	.89	2.3
	10	X	10	986	34.9	7.2	.89	2.3
	12	X	10	1158	33.2	7.2	.89	2.3
Scientists	8	X	10	1049	34.8	4.8	.64	2.7
	10	X	10	986	35.2	4.7	.68	2.5
	12	X	10	1158	34.8	4.6	.67	2.5
Science and Society	8	Y	12	1050	42.4	6.9	.82	2.9
	10	X	12	986	43.4	6.2	.81	2.6
	12	X	12	1158	43.7	6.2	.82	2.6
Careers in Science	8	Z	10	1045	31.5	7.9	.91	2.3
	10	Y	10	1004	30.1	8.4	.92	2.3
	12	Y	10	1158	30.7	8.2	.91	2.4
Methods of Science	10	Y	10	1004	35.1	3.9	.50	2.6
	12	Y	10	1158	34.9	3.9	.50	2.6

In developing the affective scales the Contract Team hoped that each scale would provide an effective instrument for teachers to use informally in assessing class attitudes in the future, and that the scales would also be appropriate (from a measurement point of view) for measuring change in future provincial assessments.

CHAPTER 3

GRADE FOUR RESULTS

John Sheppy

This chapter reports and interprets the achievement and affective results obtained by surveying Grade 4 pupils.

Three Science Assessment instruments, Forms 4X, 4Y, and 4Z, were prepared for this level.

Each form had the following components:

- five brief background information questions which provide the basis for the sub-groups used later in this chapter
- four science topics which pupils were asked to rate for interest and which were different on each form
- seven statements (common to all forms) regarding School Science to which pupils were asked to respond on a five-point scale from "Strongly Disagree" to "Strongly Agree"
- thirty-six multiple-choice achievement items which were different on each form

The achievement items were designed to (see Table 2.8) reflect the Grade 4 Table of Specifications. Each domain and objective was equally represented on each form. For purposes of the Assessment, it was not necessary that the forms be balanced in terms of average difficulty of items. However, for face validity purposes an attempt was made to keep the forms at approximately equal difficulty levels. The emphases on domains and objectives were determined by the Advisory Committee in consultation with the Contract Team as appropriate for, and representative of, good science instruction in the primary years. All items were reviewed twice by the Advisory Committee and by two different Review Panels. Revisions were made as required.

Each item was chosen to reflect a particular objective from a set of expanded objectives which defined each of the objectives chosen for assessment. The pool of items considered was approximately three times as large as the number of items used.

When constructing items where drawings or prose selections were part of the question, the Contract Team avoided using materials from B.C. textbooks and utilized reproductions of materials found in elementary school libraries or primary textbooks not used in B.C. Thus, an attempt was made to keep the information contained in Science Processes and Higher Level Thinking questions realistic rather than contrived. Since these materials were not always unambiguous in the original source, and since not all reproduced well, the Interpretation

Panel was sometimes critical of the graphics on the achievement forms.

The Grade 4 Interpretation Panel rated pupil achievement on each item, each objective and each domain. The item ratings were first based on the comparisons of desired and actual performance of the pupils of the province. Then, consensus procedures were used to produce a panel rating, first for questions, then for objectives, and finally for domains. Panel members used the following five-point scale:

Strong........................ST
Very Satisfactory.............VS
Satisfactory..................S
Marginal......................M
Weak..........................W

Appendix E contains all items arranged by domain and objective, shows the percentage of pupils who chose each option, and records the Interpretation Panel ratings based on the above scale.

The first section of this chapter describes the Grade 4 pupils. Sections 3.2-3.5 describe the achievement results, panel ratings, and interpretations. Section 3.6 compares the 1982 Assessment results with those of 1978. Section 3.7 describes the results of certain pupil sub-groups and Sections 3.8 and 3.9 examine the performance of pupils on the attitude and interest items.

3.1 Description of the Pupils In the Survey

The pupils eligible to write the Grade 4 Science Assessment instruments were all of the Grade 4 pupils in 63 British Columbia school districts and all pupils from selected schools in the 12 largest districts. The number of pupils who wrote was 27 944 which was 94% of the eligible pupils or 76% of all Grade 4 pupils. The number of pupils completing each of the forms was 9330 for Form X, 9310 for Form Y, and 9304 for Form Z.

Of these pupils, nearly 51% were boys and 49% were girls. The median age was 9.8 years. The age distribution is shown in Table 3.1. Thirteen percent learned English as a second language and seven percent still speak their first non-English language at home.

3.2 Domain 1--Science Processes

Early in the Assessment, it was decided that the Grade 4 instruments would stress achievement in Science Processes (Goal B of the Elementary School Science Program). Therefore, 56 % of the items were asked in this domain. The Elementary Science Curriculum Guide, Grades 1-7 (1981) and its predecessor, the Interim Guide 1977, list and describe 12 processes as sub-goals for elementary school science, but emphasize only five of these at the primary level. The decision was made to stress Observe and Infer, Classify, and Communicate on the Grade 4 Assessment, but also to include a small number of items on Quantify. These processes were chosen as being most appropriate because of their importance, because of the feasibility of writing valid multiple-choice questions, and because Classify and Communicate were objectives which also could be assessed at the Grade 8 level.

Table 3.1: Ages of Pupils Writing Grade 4 Achievement Forms in 1978 and 1982

Age in Years	Percent of Pupils	
	1978	1982
11 or older	4	4
10	29	32
9	67	61
8 or younger	1	2

In writing expanded objectives and items, the Contract Team discovered that the processes of science, as conventionally described, were not always independent of one another. For example, classification requires some level of observational skills as a prerequisite, and it is difficult to know whether to call the recognition of specific similarities between two specimens a sub-skill of observation or a sub-skill of classification. The boundary between observation skills and inference skills is even less distinct. So, while one can cite paradigmatic examples of each process and while, at their extremes, they may be quite distinct, at their common boundary there is considerable overlap. Much the same situation exists for other areas which this science assessment sought to investigate: inference, interpreting data, identifying variables, and the elements of the thought process the Elementary Science Curriculum Guide Grades 1-7 (1981) calls "critical thinking".

In measuring this domain and Domain 3, Higher Level Thinking, there exists great difficulty in presenting adequate, non-trivial, unambiguous data for pupils to operate upon in forms which are brief and in appropriate language.

3.2.1 Observe and Infer

The Elementary Science Curriculum Guide Grades 1-7 (1981) defines observing as "the perception of characteristics, similarities, differences, and changes through use of the senses" (p. 7). A similar statement can be found in previous guides. Multiple-choice items, printed in black on white, placed a number of limitations on measuring observation skills. Some of these were:

- the restriction to the use of visual observation only--other senses are excluded

- the restriction to observations of two-dimensional, pictorial, or diagrammatic representations rather than observations of naturally occurring objects. It was possible to avoid this restriction only in Item Z20 (see Appendix E)

- the inability to require observations using colour discriminations

- the restriction to observations of static situations

Examination of relevant tests and literature in elementary science provided few examples of suitable questions that could be used and few models for suitable questions.

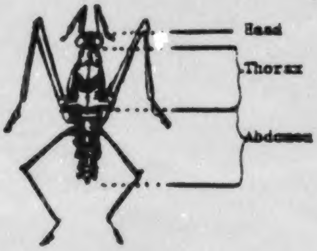
Despite these limitations, the Contract Team found that it could develop questions relating to recognition of similarities, differences, symmetry, basic shapes, and relative size. It was also possible to ask questions about the use of some instruments of observation, about how particular observations might be collected, and about the most relevant observations regarding a problem.

Sample items used for measuring observation are Z07 and Z08, where pupils were called upon to recognize a basic shape and to make a length comparison. For Z08, members of the Interpretation Panel felt that many children could have been confused by the terms "about" and "much".

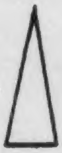
In planning the Assessment instruments, the process of inference was added to that of observation. The curriculum guide defines inference as "the derivation of premises or conclusions concerning data, using past experience" (p. 8). In the construction and selection process, few items measuring inference skills survived because of the difficulty in obtaining questions which were not too complicated but which still provided data from which tentative inferences could be made. Only item Z16 met the criterion of being an inference item, although item Y34 required pupils to distinguish between observations and inferences (see Appendix E).

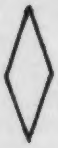
Table 3.2 summarizes pupil performance data and Interpretation Panel ratings of that performance on the Observe and Infer objective. Performance on four questions was rated as "Strong", eight as "Very Satisfactory", on two as "Satisfactory", two as "Marginal" and two as "Weak". The Panel rating for this objective was "Very Satisfactory". If performance on the limited range of observation skills measured is representative of the wider range of skills that should be taught, pupils at the Grade 4 level are learning to be good observers of their natural environment.

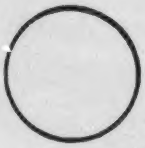
Here is a picture of an insect called a WATER STRIDER. Its body is made of three parts: head, thorax and abdomen. Use this picture to answer questions 7 and 8.



Z07 Which shape below is MOST like the shape of its body?


A


B


C

A.	10
B.	85*
C.	3
I don't know	2

Z08 Look at the picture of the water strider again. The thorax is

about as long as the abdomen.	58*
much longer than the abdomen.	9
much shorter than the abdomen.	25
I don't know.	9

* correct response

Table 3.2: Provincial Results for the Grade 4 Objective Observe and Infer

Item No.	Description	Percent Correct	Panel Rating
1.1.01(X01)	Knows weight sensed by lifting	89	VS
1.1.02(X17)	Recognizes bilateral symmetry	50	M
1.1.03(X25)	Compares relative sizes	78	VS
1.1.04(X28)	Recognizes pattern in context	87	ST
1.1.05(X29)	Recognizes pattern in context	91	ST
1.1.06(X36)	Selects sequence showing change	92	ST
1.1.07(Y04)	Knows use of magnifying glass	91	VS
1.1.08(Y09)	Recognizes differences	89	ST
1.1.09(Y15)	Selects sequence showing change	84	VS
1.1.10(Y26)	Compares relative sizes	76	S
1.1.11(Y34)	Distinguishes observations from inferences	28	W
1.1.12(Y35)	Selects appropriate observation	78	VS
1.1.13(Z04)	Compares quantitative attribute	73	S
1.1.14(Z07)	Selects basic shape	85	VS
1.1.15(Z08)	Compares relative dimensions	54	M
1.1.16(Z09)	Knows the sense a thermometer aids	31	W
1.1.17(Z16)	Makes appropriate inference	78	VS
1.1.18(Z20)	Matches diagram with object	88	VS
	Mean Percent Correct	74.5	
	Overall Rating	Very Satisfactory	

It is worthy of note that pupils did well on most questions where quantitative comparisons were called for, or where matching was the skill required. On three of the four items where comparative size or number was requested, the results were also good and the fourth such item (Z08) may have contained the language difficulty discussed above. Interpretation Panel members were surprised by the difficulty children found with the questions on symmetry (X17) and on separating inferences from observation (Y34). On this latter question, some panelists felt that children may equate the word "observe" with the word "see". If this is true, teachers are encouraged to generalize their use of the term "observe". Question Z09 provided the Panel with much ground for debate. Many pupils seem to have thought that, since one reads a thermometer visually, the sense which is aided is sight. An important concept is at stake here. At the primary level, pupils should be reading thermometers, clocks and spring balances, and as they mature they should be introduced to a variety of measuring devices. Most of these will be visually read, but the observations made are on non-visual properties.

3.2.2 Classify

The Elementary Science Curriculum Guide, Grades 1-7 (1981) defines classification as the "organization of materials, events, and phenomena into logical groupings. At first, classification is a sorting process" (p. 7). The measurement situation placed limits on what could be done. The use of real objects or matter was not feasible, nor could events and phenomena be presented. The Contract Team was restricted to the use of representations or to objects expected to be familiar to nearly all children. Previous tests provided examples of items in which pupils indicated the group or class to which an unclassified object belonged (Z35), items in which the attributes of a class are inferred from sets of examples and non-examples and then a new member of the class is identified ((Z26) "Recognizes and applies class rule" in Table 3.3.), or items in which pupils identified the basis for classification (Y11).

Item Z17 is an example of a non-pictorial variation of the "recognizes and applies class rule" type of question which is not found in the literature. It illustrates the kind of situation in which the Contract Team expected pupils to be familiar with the characteristics of the twelve mammals whose names are given. They expected the term "feline" to be unknown to the children and therefore to give no clue to the correct answer as in the other examples where "wibbles", "plaps," and "hewts" are uninformative terms. On this item, the p-value of the "I don't know" response is quite high, but is comparable to that in similar questions. There are indications elsewhere in the Assessment that a proportion of pupils chose this response whenever an unfamiliar term or unfamiliar content was presented, perhaps without seeking to understand the question (see Items X05, Y19, Y25, Z26, X32 in Appendix E).

Table 3.3 summarizes the data on student performance and the Panel ratings. Only one item was rated as "Strong", five were "Very Satisfactory", six were "Satisfactory", five were "Marginal" and one was "Weak". The Interpretation Panel felt pupil performance on this objective was "Satisfactory".

Z17 All of these are felines.

Lion
Cougar
Cat
Cheetah

None of these is a feline.

Wolf
Bear
Cow
Bat

Which one of the following is a feline?

Dog	6
Seal	3
Beaver	2
Tiger	74*
I don't know	13

* correct response

Where attributes were stated, children matched or deleted well. When pupils were asked to select the basis on which a grouping had been made, they did not achieve as well. Item X19 assumed that pupils knew the dietary habits of eight animals, which some pupils may not have known. But this assumption is not unlike those made frequently in teaching where it is not always possible to work without assuming prior knowledge. Item Z10 may present some ambiguities since buttons are sometimes made of metal. The group of items which required pupils to infer or recognize and then use a class rule varied in difficulty. On the whole, pupils found them quite difficult, although only one item involved the isolation of more than one attribute. The form of thinking involved here may be foreign to many children since class concepts are often taught by presenting positive examples only. Placing new objects in an established class, an extremely common task in science, was found difficult only in X31 where the established class was not well known to the pupils and was based on hidden characteristics.

Table 3.3: Provincial Results for the Grade 4 Objective Classify

Item No.	Description	Percent Correct	Panel Rating
1.2.01(X05)	Recognizes and applies class rule	51	M
1.2.02(X06)	Matches by stated attribute	83	VS
1.2.03(X07)	Uses two-way classification chart	59	M
1.2.04(X09)	Deletes least similar shape	48	W
1.2.05(X19)	Recognizes basis for sorting	69	S
1.2.06(X31)	Puts new object into best class	67	S
1.2.07(Y11)	Recognizes basis for sorting	51	M
1.2.08(Y18)	Deletes by stated attribute	80	VS
1.2.09(Y19)	Recognizes and applies class rule	58	M
1.2.10(Y25)	Recognizes and applies class rule	45	S
1.2.11(Y27)	Uses two-way classification chart	72	S
1.2.12(Y33)	Puts new object into best class	88	ST
1.2.13(Z10)	Recognizes basis for sorting	57	S
1.2.14(Z13)	Matches by stated attribute	85	VS
1.2.15(Z17)	Recognizes and applies class rule	75	VS
1.2.16(Z21)	Deletes least similar object	70	VS
1.2.17(Z26)	Recognizes and applies class rule	41	M
1.2.18(Z25)	Places new object into best class	78	S
	Mean Percent Correct	65.3	
	Overall Rating	Satisfactory	

3.2.3 Communicate

The Contract Team analyzed and listed the ways in which scientific information is communicated to pupils and by pupils. The listing included the spoken word, the written word, pictures, diagrams and maps, symbols, charts and tables, and graphs. The written work is used, among other things, to describe objects and phenomena, to convey concepts, and to give instructions.

Since textbooks, encyclopedias, science trade books, guide books, and pamphlets are used to convey information, and since teachers frequently refer pupils to these, the Contract Team felt it appropriate to include in this section some questions in which information was given in the form of short paragraphs. Obviously, the measurement situation precluded the use of spoken communication and of pupil-initiated communication. Achievement items were constructed to explore pupils' ability to extract information from a variety of presentation modes.

Table 3.4 shows the provincial results and Panel ratings for the questions on this objective. One item received a "Strong" rating, three were "Very Satisfactory", three were "Satisfactory", eight were judged to be "Marginal" and three were "Weak". The Panel rated provincial performance on this objective as "Marginal".

Five items dealt with tables, and performance on these was superior to that on other items in this section. Only X13, of the items dealing with tables, was rated "Marginal", and the wording of this item was a bit awkward. It does, however, seem that, in reading both graphs and tables, pupils have difficulty moving from the body of the graph or table to the scales. Pupils found the two items utilizing symbols difficult. The results indicate that it is very probable that the use of any kinds of symbols, other than letters and numbers, is not stressed in primary-level work. Pupils' results on work with science writing were disappointing, and all six items were rated "Marginal" or "Weak". Two of these items required children to think in terms of right-left orientation, and therefore involved more than reading comprehension. In the other items, the incorrect answers selected suggest that pupils are using only parts of the information they read. Most items with a significant reading component produced a substantial response to the "I don't know" option.

Graph reading and interpreting skills were measured by five items. The Panel pointed out that all graphs provided were line graphs and that primary pupils are more familiar with bar graphs. Z32 is an easy item and Z33 a difficult item based on the same graph. Grade 4 pupils seem to have little difficulty in straightforward reading of graphs and tables. However, they do not appear to be experienced in interpretation, as in Z33, where most pupils failed to realize "slowest" means "takes the most time" rather than "the least time to run around the track".

Table 3.4: Provincial Results for the Grade 4 Objective Communicate

Item No.	Description	Percent Correct	Panel Rating
1.3.01(X04)	Selects first of scrambled steps	35	W
1.3.02(X12)	Reads and interprets a table	82	VS
1.3.03(X13)	Reads and interprets a table	41	M
1.3.04(X24)	Recognizes meaning of new symbols	35	M
1.3.05(X32)	Selects best picture of a description	40	W
1.3.06(X33)	Recognizes correct graph	47	M
1.3.07(Y05)	Reads graph	67	S
1.3.08(Y06)	Reads graph	73	S
1.3.09(Y07)	Selects most relevant statement	54	M
1.3.10(Y23)	Selects best picture of a description	50	M
1.3.11(Y29)	Selects best diagram of a description	40	M
1.3.12(Y31)	Reads and interprets a table	67	S
1.3.13(Z02)	Reads a table	93	ST
1.3.14(Z03)	Reads and interprets a table	87	VS
1.3.15(Z28)	Interprets symbols in content	27	W
1.3.16(Z31)	Selects best diagram of a description	58	M
1.3.17(Z32)	Reads a graph	84	VS
1.3.18(Z33)	Reads and interprets a graph	25	M
	Mean Percent Correct Overall Rating	55.9 Marginal	

3.2.4 Quantify

Only six items were used to explore this objective, despite its importance in science since the Contract Team and the Advisory Committee felt that the whole area of measurement was well explored by the 30 questions used in the B.C. Mathematics Assessment in 1981. The "Marginal" ratings given to the Measurement domain on that Assessment are confirmed by the Science Assessment Interpretation Panel's rating of "Marginal" on the Quantify domain. Because of the importance of this process, and because of the stress they felt it should be receiving, the Interpretation Panel members' expectations in this area were high. Table 3.5 presents provincial results and Interpretation Panel ratings for this objective.

Table 3.5: Provincial Results for the Grade 4 Objective Quantify

Item No.	Description	Percent Correct	Panel Rating
1.4.01(X16)	Reads Celsius thermometer	46	M
1.4.02(X22)	Knows kilograms measure mass	65	M
1.4.03(Y03)	Matches instrument to quantity to measure	65	M
1.4.04(Y13)	Knows need for initial measurement	69	S
1.4.05(Z23)	Selects best measuring instrument	40	M
1.4.06(Z24)	Knows metres measure distance	79	S
	Mean Percent Correct	60.4	
	Overall Rating	Marginal	

Three of the items differed from any in the Mathematics Assessment. Items Y03 and Z23 required knowledge of the appropriateness of instruments of measurement, and Y13 was directed at the need for an initial measurement if change is to be shown. The results on Item X16, reading the Celsius thermometer, are questionable because there was a misprint on the scale, and also the printing (a reproduction of a thermometer widely used in elementary schools rather than a diagram) was not as clear as it might have been. The most frequently chosen incorrect answer for this item indicates ability to read a Celsius thermometer even if it does not indicate good precision in reading it. Item Z24 could have been confusing to pupils because longer distances are more frequently measured in kilometres than in metres.

3.2.5 Summary and Recommendations

The Interpretation Panel rated pupil performance on the domain of Science Processes as "Satisfactory", based on "Very Satisfactory" performance on Observe and Infer, "Satisfactory" performance on Classify and "Marginal" performance on each of Communicate and Quantify.

The Contract Team concurs with the Interpretation Panel in its recommendations to teachers that:

- pupil-oriented, hands-on activities, followed by class discussion and interpretation, rather than teacher-oriented reading/ lecture activities, be stressed in elementary school science
- more time and emphasis in teaching be given to teaching quantification and to the use of the metric system
- pupils be given more practice in presenting results in symbolic forms, e.g. charts, graphs, and diagrams

3.3 Domain 2--Knowledge: recall and understand

Goal C in the B.C. Elementary Science Curriculum Guide, Grades 1-7 (1981) states that:

> The Elementary School Science Program should develop in pupils scientific knowledge.

The student should demonstrate and apply knowledge of the following:

- facts, generalizations, concepts, principles, and laws;
- scientific vocabulary;
- relationships between various scientific disciplines;
- the history, philosophy, and nature of science;
- the application and limitations of science in the practical world. (Page 9)

For the purposes of this Assessment it was decided to restrict measurement in this domain to demonstrating knowledge, and to place items relating to applying knowledge in Domain 3, Higher Level Thinking. Items were chosen to measure recall and understanding as these terms are commonly defined in the literature of evaluation. Three objectives were chosen: Biological, Physical and Earth/Space Science Concepts, Applications of Science (Technology) and the Nature of Science, and Safety Procedures. This domain, while considered important for the primary grades, was not given the same priority as the Science Processes domain. Thirty-one percent of the achievement items were devoted to the Knowledge domain.

3.3.1 Knowledge of Biological, Physical and Earth/Space Science Concepts

Most science testing in the past has concentrated upon the knowledge of science concepts, and there are good questions and models available. Most of the 18 items in this section were selected or adapted from other sources. A balance was kept among biological, physical, and earth/space science items. For inclusion in the assessment instruments, an item had to have its content drawn from an area which was part of the primary content of at least two of the three prescribed programs in British Columbia. The content of many of the items appears in all three programs.

Table 3.6 presents the provincial results and Panel ratings for this objective. Only two items received a "Very Satisfactory" rating, six were "Satisfactory", nine were rated "Marginal", and one was rated "Weak". The Panel rated provincial performance on this objective as "Marginal".

The Interpretation Panel expressed disappointment regarding pupils' performance on this objective and wondered if it was being understressed in science programs. The Panel was particularly concerned with the poor performance of pupils on Items Y08 and Z30 (relating to Celsius temperature) and Item X16 (discussed earlier).

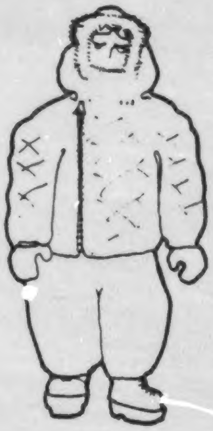
It is interesting to note that many pupils (42%) on Item Z30 incorrectly chose typical cool weather dress, not dress for a 25° day. One wonders how often teachers use their 20°-22° classrooms as a reference point in comparing temperatures.

The results from the other items were examined, but no clear patterns of strengths or weaknesses emerged. Individual items created some comment. There were doubts that Grade 4 pupils understood the word "dissolve" in Item X23, that Item X26 was valid even if its difficulty were discounted, and that it was wise or fair to include Z14 on life-form succession (see Appendix E).

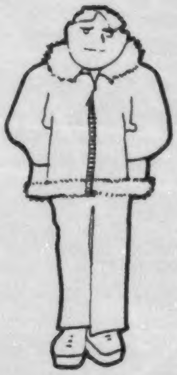
Table 3.6: Provincial Results for the Grade 4 Objective Biological, Physical and Earth/Space Science Concepts

Item No.	Description	Percent Correct	Panel Rating
2.1.01(X02)	Knows cause of year	63	M
2.1.02(X08)	Knows how a plant develops	83	VS
2.1.03(X11)	Knows sun is source of energy	66	S
2.1.04(X15)	Knows how soil components separate	68	S
2.1.05(X23)	Knows solubility of common substances	49	M
2.1.06(X26)	Knows role of bacteria in disease	33	M
2.1.07(Y08)	Knows meaning of common temperatures	47	M
2.1.08(Y10)	Knows air occupies space	50	M
2.1.09(Y12)	Knows about life cycles and reproduction	46	M
2.1.10(Y14)	Knows functions of plant parts	51	M
2.1.11(Y20)	Knows about expansion and contraction	54	S
2.1.12(Y22)	Knows how cells must be connected	59	S
2.1.13(Z05)	Knows function of lungs	60	S
2.1.14(Z11)	Knows characteristics of some environments	75	VS
2.1.15(Z14)	Knows succession of life forms	41	M
2.1.16(Z29)	Knows how compasses work	51	M
2.1.17(Z30)	Knows meaning of common temperatures	32	W
2.1.18(Z34)	Knows erosion wears rocks smooth	60	S
	Mean Percent Correct Overall Rating	54.8 Marginal	

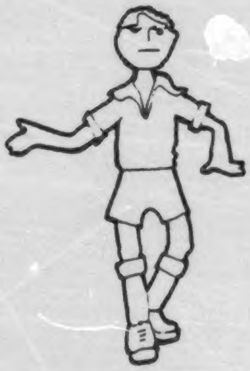
Z30 Look at the pictures below.



A



B



C

When the temperature outside is 25°C, how should you dress?

A	19
B	42
C	30*
I don't know	8

* correct response

3.3.2 Knowledge of the Applications of Science (Technology) and the Nature of Science

In this objective, two seemingly dissimilar areas of knowledge were probed. The connection between them comes from the perspective children should develop regarding science in the world outside of school. Those involved in the Assessment recognize that Grade 4 pupils will nave barely started to gain knowledge in this area and so only six items were used to assess this objective. Three items related to knowledge of the uses of science in the environment. It is surprising that children know the source of leather (86% on Y02) so much better than they know that one eats the roots of carrots (49% on X03). Three items were related to knowledge about the nature of science or the scientific enterprise. For their age level, pupils answered these quite well.

Table 3.7 presents the provincial results and Panel ratings for this objective. The overall rating was "Satisfactory", although the Panel felt that there were too few items used for this objective.

Table 3.7: Provincial Results for the Grade 4 Objective Applications of Science (Technology) and the Nature of Science

Item No.	Description	Percent Correct	Panel Rating
2.2.01(X03)	Knows useful plant products	49	M
2.2.02(X30)	Knows how scientific knowledge is verified	76	S
2.2.03(Y02)	Knows useful animal products	86	VS
2.2.04(Y24)	Knows some scientific specialties	67	S
2.2.05(Z12)	Knows some public health measures	50	S
2.2.06(Z19)	Knows importance of quantification in science	72	VS
	Mean Percent Correct	66.8	
	Overall Rating	Satisfactory	

3.3.3 Knowledge of Safety Procedures

Safety in school science has become a major concern in recent years and it was felt that this area should receive some stress in the Assessment. Therefore, nine items were used. Five of these asked pupils to indicate what should or should not be done in particular situations. The other four items asked pupils why a hazard existed or why a particular precaution should be taken. The Interpretation Panel felt that it was more important to know that a hazard exists than to know why it exists. However, in situations where pupils have contact with common materials such as a drain cleaner (X14) and gasoline (X35), teaching the reasons why is also an important function of science classes. Panel members' expectations were high for performance in this area, and many felt that a 100% response was desirable on most of the items. Table 3.8 presents the provincial results and Panel ratings for this objective. Because of its importance to pupils themselves, the Panel rated performance on Safety Procedures as only "Marginal".

Particular concern centres around the weak knowledge of children regarding what to do if their clothing catches fire. Teachers are urged to instruct pupils in procedures in case of fire. Item Y01, regarding determining if an object is hot, causes some concerns. It is alarming that nine percent of the pupils would actually touch the object. Several Panel members questioned the validity of this item, perhaps because they were more familiar with methods used in the kitchen to test if the temperature of a pan or an iron is sufficiently high rather than with the method taught in most science classes. The problem in relying upon the behaviour of droplets of water on a hot surface is twofold:

t, the method can only be used with metals, not with hot glass or porcelain; second, objects below the temperature at which water droplets dance can e severe burns.

able 3.8: Provincial Results for the Grade 4 Objective Safety Procedures

n No.	Description	Percent Correct	Panel Rating
.01(X14)	Knows hazard of lye and drano	37	W
.02(X20)	Knows procedures in case of fire	44	W
.03(X35)	Knows hazard of gasoline	83	S
.04(Y01)	Knows how to test hot metal	37	W
3.05(Y21)	Knows procedures for broken glass	80	S
3.06(Y32)	Knows field trip procedures	86	S
3.07(Z01)	Knows reason for light coloured clothing	94	ST
3.08(Z15)	Knows to leave unknown materials alone	88	VS
3.09(Z25)	Knows animal hazards	70	M
	Mean Percent Correct Overall Rating	68.8 Marginal	

The responses to Item Y21 (shown below) cause some concern. While it is ommendable that 80% of the pupils will let the teacher handle the situation, here are still 16% prepared to do something themselves. The Contract Team dvises teachers to give pupils clear instructions regarding the common hazard of roken glass, and reminds teachers of their liability should pupils be cut by ouching bits of broken glass.

Y21 During science class, you drop a glass jar and break it. There is glass all over the floor. What should you do?

Try to pick up the pieces yourself	3
Throw the broken pieces into the wastepaper basket .	6
Do not touch the glass, but tell the teacher right away	80*
Brush up the glass with a paper towel	7
I don't know	3

* correct response

3.3.4 Summary and Recommendations

The Interpretation Panel rated achievement in the Knowledge domain as "Marginal", though nearly "Satisfactory", with the greatest concerns in the area of safety procedures.

The Contract Team concurs with the Interpretation Panel in its recommendations to teachers that:

- safety procedures need to be more thoroughly stressed
- science concepts need to be stressed more strongly in teaching

The Contract Team points out that the amount of time many teachers spend on science teaching is minimal, as discussed in Section 6.6.2, and feels that increasing times, to those delineated by the Ministry of Education, could help achieve these recommendations.

3.4 Domain 3--Higher Level Thinking

Two objectives constituted this domain. The first was Apply Biological, Physical and Earth/Space Science Concepts discussed in Goal C in the Elementary Science Curriculum Guide, Grades 1-7 (1981). The second objective in the domain was an attempt to assess achievement in Goal D, "The Elementary School Science Program should develop in students creative, rational, and critical thinking" (page 9). Since creative thinking is not accessible to measurement by the multiple-choice format, the second objective became Use Rational and Critical Thinking. Since pupils were expected to have limited science concepts at this level, a limited range of application items was possible, and it was expected that critical and rational thinking would not be well developed. Only 13% of the achievement survey items were asked on this domain.

3.4.1 Apply Biological, Physical and Earth/Space Science Concepts

This objective sought to measure the ability of pupils to take knowledge they possess and use it in a new situation. Two difficulties are encountered when measuring for application skills. They are:

- The pupils may not possess the requisite knowledge
- The situation expected to be new for pupils may, in fact, be one that is familiar to some. They may have learned the solution to the problem by previously applying the knowledge or by previous instruction

Inevitably, in application level items there are two possible reasons for getting an item wrong: failure to possess the required knowledge or failure to apply knowledge. There are also two possible reasons for getting the item correct: application of knowledge possessed or knowledge of the correct solution attained through previous learning. The Contract Team tried to provide items which would be true application items for the majority of pupils, but two items used may have been knowledge level for many children. These were Y28, on wind effects, and Z36, on conditions for plant growth. One other (Y30) could also have been classified as a Quantify question.

The provincial results and Interpretation Panel ratings are shown in Table 3.9 for the Apply of Biological, Physical and Earth/Space Science Concepts objective. The overall rating given was "Satisfactory".

The Interpretation Panel pointed out that the illustration for Y36 was slightly inaccurate, and that children may have had experience with forcing bulbs of hyacinths, etc. which could mislead them in Item Z36. The Panel also felt that the word "turned" in Item Z27 could have been interpreted as "revolve" rather than "rotate". Incorrect responses to Item X18 indicate that the concept "food chain" was unavailable to a large number of pupils and so could not be applied. The relatively poor performance on Z22 is further evidence of pupils' unfamiliarity with Celsius temperatures.

Table 3.9: Provincial Results for the Grade 4 Objective Apply Science Concepts

Item No.	Description	Percent Correct	Panel Rating
3.1.01(X10)	Applies knowledge of shadows	49	S
3.1.02(X18)	Assembles a simple food chain	37	W
3.1.03(X34)	Applies knowledge of solar system relations	85	ST
3.1.04(Y28)	Applies knowledge of wind speed effects	94	ST
3.1.05(Y30)	Applies knowledge of measuring instruments	58	S
3.1.06(Y36)	Applies knowledge of shadows	44	M
3.1.07(Z22)	Applies knowledge of Celsius temperature	50	M
3.1.08(Z27)	Applies knowledge of solar system	52	S
3.1.09(Z36)	Applies knowledge of plant growth conditions	47	M
	Mean Percent Correct Overall Rating	57.5 Satisfactory	

3.4.2 Use Rational and Critical Thinking

In the Elementary Science Curriculum Guide, Grades 1-7 (1981) rational thinking is defined as "the ability to look for natural causes of events" (page 9) and critical thinking is defined as "the ability to identify central issues, to recognize underlying assumptions and to evaluate evidence. The student should be able to recognize stereotypes and biases, to identify essential, verifiable and adequate data, and to draw conclusions" (p.9). The Contract Team used these definitions in constructing items for this objective. In searching the literature, very few examples of questions on levels of thinking higher than application were found for young children. Almost all previous work in this area has been done with people of secondary school age or older. Because thinking requires data, the items of this section contained more reading than most of the other items. However, unlike some other parts of the instrument, the "I don't know" response was not heavily used.

Table 3.10 presents the provincial results and the Interpretation Panel ratings. On this objective, the Panel felt that pupils' performance was "Very Satisfactory."

Table 3.10: Provincial Results for the Grade 4 Objective
Use Rational and Critical Thinking

Item No.	Description	Percent Correct	Panel Rating
3.2.01(X21)	Recognizes natural causes as explanations	67	S
3.2.02(X27)	Selects underlying assumption	61	S
3.2.03(Y15)	Identifies underlying point-of-view (bias)	79	VS
3.2.04(Y17)	Identifies underlying point-of-view	65	S
3.2.05(Z06)	Selects data which will support statement	87	VS
3.2.06(Z18)	Recognizes natural causes as explanations	71	VS
	Mean Percent Correct	71.7	
	Overall Rating	Very Satisfactory	

Two items, X21 illustrated below and Z18, dealt with rationality and, for the age of the pupils, the results are gratifying, although there was still a substantial proportion who are not committed to the scientific view that natural events have causes.

X21 In 1980 Mt. Saint Helens blew up. What is the BEST explanation for the happening?

The mountain was angry.	2
Pressures became great inside the mountain.	66*
Scientists will never explain it, because things like volcanos cannot be explained.	22
I don't know.	8

* correct response

3.4.3 Summary and Recommendations

The Interpretation Panel rated performance in Domain 3, Higher Level Thinking, as "Satisfactory", and reconfirmed its recommendation in Section 3.2.5 that manipulative and experimental activities be increased.

3.5 Summary of the Grade 4 Achievement Results

Table 3.11 summarizes the Interpretation Panel ratings for the Grade 4 achievement instruments. Two domains received "Satisfactory" ratings and one a "Marginal" rating. Overall, the Interpretation Panel expressed mild disappointment with the standard of achievement in science at the primary level.

Table 3.11: Summary of Domain and Objective Ratings for Grade 4

Domain or Objective	Rating					Mean Percent Correct	Domain or Objective Rating
	ST	VS	S	M	W		
1. Science Processes							
1.1 Observe and Infer	4	8	2	2	2	74.5	VS
1.2 Classify	1	5	6	5	1	65.3	S
1.3 Communicate	1	3	3	8	3	55.9	M
1.4 Quantify	0	0	2	4	0	60.4	M
Process Domain	**6**	**16**	**13**	**19**	**6**	**64.8**	**S**
2. Knowledge							
2.1 Science Concepts	0	2	6	9	1	54.8	M
2.2 Applications (Technology) /Nature of Science	0	2	3	1	0	66.8	S
2.3 Safety Procedures	1	1	3	1	3	68.8	M
Knowledge Domain	**1**	**5**	**12**	**11**	**4**	**60.8**	**M**
3. Higher Level Thinking							
3.1 Apply Science Concepts	2	0	3	3	1	57.5	S
3.2 Use Rational and Critical Thinking	0	3	3	0	0	71.7	VS
Higher Level Thinking Domain	**2**	**3**	**6**	**3**	**1**	**63.2**	**S**

Table 3.12: Grade 4 Pupils' Achievement in Biological, Physical and Earth/Space Science Content Areas

Biological Science			Physical Science			Earth/Space Science		
Item No.	Percent Correct	Panel Rating	Item No.	Percent Correct	Panel Rating	Item No.	Percent Correct	Panel Rating
For Objective 2.1								
X08	83	VS	X11	66	S	X02	63	M
X26	33	M	X23	49	M	X15	68	S
Y12	46	M	Y20	54	S	Y08	47	M
Y14	51	M	Y22	59	S	Y10	50	VS
Z05	60	S	Z29	51	M	Z11	75	S
Z14	41	M	Z30	31	W	Z34	60	M
Mean Percent Correct	52.3			51.8			60.5	
Items from other objectives which required pupil use of Knowledge not supplied (in order of appearance in Appendix E)								
X19	69	S	X14	37	W	Y24	67	S
X31	67	S	X35	83	S	X34	85	ST
Y27	72	S	Z01	94	ST	Y28	94	ST
Z17	75	VS	X10	49	S	Z27	52	S
X03	49	M	Y36	44	M			
Y02	86	VS	Z22	50	M			
Z25	70	M						
X18	37	W						
Z36	47	M						
Mean Percent Correct	53.5			59.5			74.5	

The Interpretation Panel requested a further analysis of the achievement results in terms of the science content areas (Biological, Physical, and Earth/Space Science). This analysis was not contemplated in the original design of the Assessment, and, even for Objective 2.1 (Section 3.3.1), it is difficult to classify all items uniquely. For example, should the item on what to wear on a 25°C day (Z30) be treated as a Weather (Earth Science) item or as a Heat-Temperature (Physical Science) item? Some items in other sections of the instrument required that pupils recall knowledge in order to use it for the primary purpose of the item. Other items used content from a science area, most of which was presented in the items. These later items, (e.g. Y13), are excluded from the analysis. Table 3.12 above presents the analysis requested.

Readers are cautioned that many of the items in the second listing above required more than knowledge of concepts. Since the instruments were not designed to compare achievement in the various science areas, differences observable above may be due merely to random differences in item difficulty. The important data are the Panel ratings for the items.

3.6 Comparisons with the 1978 Science Assessment

In the 1978 Science Assessment, there was one Grade 4 instrument consisting of 68 items split into two parts which were administered on the same day with a rest period between. The total time allotted was 80 minutes. The teacher who administered the instrument read the stem for each item aloud but not the answer options. The 1982 Science Assessment administration time was limited to 45 minutes per class. The maximum number of achievement items that could be placed on an instrument was 36 items. Since this did not allow sufficient items to measure the range of objectives desired, it was decided to use three forms and, to ensure random distribution of these, each form was to be used by pupils in every participating classroom. This made it impossible for teachers to read the stem of the questions aloud.

Therefore, no definitive statement can be made comparing Grade 4 pupils' achievement in 1978 with 1982. The 1982 Assessment format will be more amenable to such comparisons in the future.

The distribution of ratings given by the two Interpretation Panels is shown in Table 3.13. This comparison uses the judgement of informed individuals rather than objective data. It is important to note that the two Interpretation Panels were judging pupils' performances at different tasks because of different administrative procedures and item differences between the two assessments. However, the Panels were expected to use their informed knowledge of the capabilities of pupils in making their judgements. As the table shows, the 1978 Panel felt pupil performance in 1978 to be substantially better than the 1982 Panel felt it to be in 1982. The 1978 report stated "Generally the Grade 4 results were pleasing" (p.63). In 1982, a comment such as this cannot be made.

3.7 Achievement of Specific Pupil Sub-Groups

A representative sample of just over 10% of the Grade 4 pupils who wrote the instrument was selected for further analysis. The analysis involved analysis of variance procedures to analyze the date by gender, language now spoken, and language first spoken. These data were obtained from pupil responses to the background information questions. A chi-square analysis of each item by gender was also carried out.

Table 3.13: Distribution of Ratings of Student Performance in 1978 and 1982

Rating Category	Percent of Items	
	1978 (based on 68 items)	1982 (based on 108 items)
Strong	19	8
Very Satisfactory	28	22
Satisfactory	37	29
Marginal	13	31
Weak	3	10

3.7.1 Sex-Related Differences in Achievement

Table 3.14 presents the results of the analysis by gender for each domain and objective in Grade 4. There are significant differences in the achievement of boys and girls in two of the three domains at this grade level. The average achievement of girls exceeded that of boys in Domain 1--Science Processes, and on the objectives Observe and Infer and Communicate, the girls' means were different by 3.5% and 2.1% respectively.

The average achievement of boys exceeded that of girls in Domain 2--Knowledge. The boys' mean for knowledge of science concepts was 4.9% above the girls', but the girls' average score was 2.4% above the boys' on Safety Procedures. In Domain 3--Higher Level Thinking, there were no statistically significant differences.

These data were examined in conjuction with the corresponding sections for Grades 8 and 10/12, and this examination showed important trends. Compared to the girls, boys' achievement on the Science Processes parts of the instruments improved over the grades, but girls' achievement on the knowledge of science concepts was significantly below that of boys at all levels sampled. How early this knowledge deficit begins cannot be determined from these data; neither can its source. Whether the deficit comes about by an interaction of differing interests and the curriculum in school or whether it comes from differing sets of life experiences of boys and girls is not determinable from the Assessment results. As the background of science information needed to perform processes, to apply knowledge, and to think critically about situations in science grows, those individuals with greater factual knowledge will increasingly outperform those with less; this difference in achievement is shown in succeeding grades. Throughout the grades assessed, wherever the information was supplied or the previous knowledge relied on was minimal, girls' achievement was equal or superior to that of the boys', as in Domains 1 and 3 at this grade level.

Table 3.14: Grade 4 Sex-Related Differences in Attitude and Achievement

Domain/Objective	Mean Percent		Difference	Significance
	Male	Female	Male - Female	Level
Domain 1--Science Processes	64.2	65.8	-1.6	**
Objectives				
1.1 Observe and Infer	73.5	76.0	-2.5	**
1.2 Classify	64.9	66.3	-1.4	ns
1.3 Communicate	55.1	57.2	-2.1	*
1.4 Quantify	61.7	60.2	+1.5	ns
Domain 2--Knowledge	62.1	59.8	+2.3	**
Objectives				
2.1 Science Concepts	57.9	53.0	+4.9	**
2.2 Applications (Technology) /Nature of Science	68.2	66.2	+2.0	ns
2.3 Safety	66.6	69.0	-2.4	**
Domain 3--Higher Level Thinking	63.4	63.3	+0.1	ns
Objectives				
3.1 Apply Concepts	57.8	56.3	+1.5	ns
3.2 Use Rational and Critical Thinking	71.8	73.6	-1.8	ns

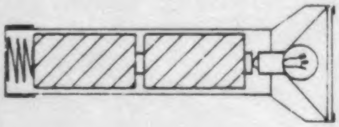
Males, N = 1462; Females, N = 1477

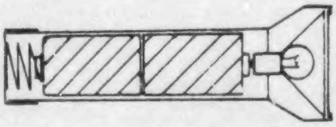
ns = not significant
* p less than .05
** p less than .01

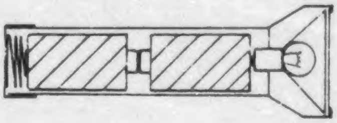
Chi-square analyses showed significant differences ($p < .05$) by gender on 36 items (one-third of the achievement items). These items were examined for clues as to the possible reasons for sex-related achievement differences, but no clear patterns emerged. In a few cases, the p-values for boys and girls were not significantly different but a significant difference was caused by different patterns of response to incorrect distractors. In some, but not all, items with a significant reading component, the girls outperformed the boys. Where there was a significant difference in correct answers in items in the knowledge of science concept objective it was always in favour of the boys. Sometimes, differences could be attributed to familiarity with an object or context, as in the better performance of boys in classifying a football (Y33) or of girls in deciding to wash a jar before using it (X04). This explanation did not always hold and it is difficult to postulate an experience difference which would favour girls with respect to shadow size (X10) and boys with respect to shadow direction (Y36). The achievement data for boys and girls are presented in Appendix J.

One item is of particular interest. Item Y22 (see below) produced the largest boy-girl difference on the Grade 4 Assessment, with 77% of the boys in the sample and only 50% of the girls getting it correct. This item was also used in 1978 when the boy-girl difference was also 27%.

Y22 Look at the diagrams below.


A


B


C

To make the flashlight work, which way must we place the batteries?

A	63*
B	22
C	11
I don't know	5

* correct response

3.7.2 Differences Related to Language Backgrounds

Analysis of variance was also used to compare pupils whose present language at home was not English to those whose language at home was English. The analysis for the domains is presented in Table 3.17. Those pupils who do not commonly speak English at home have mean domain scores about 6.5% lower than those who most commonly speak English at home. The scores for individual objectives show about the same mean difference. Only in the objective Quantify does the difference fail to reach statistical significance. When a similar analysis is done comparing those whose first language is English with those who first learned another language, the mean difference is 4.5% on domains and only the objectives Classify and Communicate fail to show a statistical significant difference.

Table 3.15: Achievement of Grade 4 Students by Language Spoken at Home

Domain	Mean Percent Correct English	 Not English	 Difference
Domain 1--Science Processes	65.4	59.8	5.6*
Domain 2--Knowledge	61.4	55.0	6.4*
Domain 3--Higher Level Thinking	63.8	56.3	7.5*

* p less than .01   N = 2736 (English) N = 203 (Non-English)

3.8 Attitudes Toward Science in School

Teachers want their pupils to enjoy all of the personal, social, and academic experiences associated with school learning. This, of course, includes liking school subjects such as science. Accordingly, the Assessment attempted to measure pupils' liking of science as a school subject through the use of a scale entitled School Science. The scale consisted of ten items at the upper grade levels, while at the Grade 4 level only the first seven items were used. The proportions of Grade 4 pupils in British Columbia who chose the various response categories for each item are recorded in Appendix E.

A description and rationale for the scale along with its measurement characteristics are contained in Section 2.3. The following analysis is based on the results of a 10% sample of Grade 4 students.

It is difficult to interpret attitude scale results with a great deal of confidence. One must ask whether the scale is measuring what it is intended to measure. For example, is the scale really measuring attitude toward school science or are the results confounded by the pupils' desires to please the teacher or to acquiesce? The reader will have to decide if the statements in the scale are appropriate for the given task.

One way to interpret attitude results is in terms of the proportion of pupils whose scores are at or above the mid-point of the scale (i.e. the proportion of pupils selecting positive responses). For the School Science scale, score 21 divides the scale into negative and positive sections. The percentile equivalent of score 21 is 20, meaning that 20% of the pupils scored below score 21 and, therefore, 80% scored at or above 21 (on the positive side of the scale). One can therefore conclude that, at the Grade 4 level, pupils' attitudes are very positive toward school science.

3.8.1 Sex-Related Differences

In order to show differences in attitudes toward school science between boys and girls, the score data for each item were collapsed from five to three categories. The two categories in the positive direction were combined and called "Positive", while the categories in the negative direction were combined and called "Negative". The "Can't Decide" category was re-labeled "Neutral". Results of the breakdown, in terms of percentages, are shown in Table 3.16.

Table 3.16: Grade 4, School Science, Sex-Related Item Response Differences

Item	Gender	Positive	Neutral	Negative
1. I Like to Study Science in School	B	60	21	19
	G	56	27	17
2. I Feel the Study of Science in School is Important	B	78	13	9
	G	79	12	9
*3. Science is Dull	B	70	14	16
	G	69	17	14
*4. I Do Not Enjoy Science	B	71	13	16
	G	70	15	15
5. I Would Like to Study More Science	B	55	22	23
	G	53	23	24
*6. Science Classes are Boring	B	69	14	17
	G	67	17	15
7. Science is a Valuable Subject	B	73	16	11
	G	68	21	11

* "Disagree" and "Strongly Disagree" responses to negatively stated items were combined and placed in the "Positive" column.

The results give a different perspective to the data. One can see the variability of response patterns across gender as well as across items. For simplicity in reading, the highest percentage in the positive category between boys and girls has been underlined. Results show that boys obtained the majority of the higher percentages.

From the foregoing, one may conclude that pupils in Grade 4 enjoy school science. Further, boys tend to be slightly more positive than girls toward science as a school subject.

3.8.2 Cross-Grade Differences

Pupils in grades 4, 8, 10, and 12 have had vastly different experiences within science curricula as well as within the broader social culture. One can, therefore, be quite certain that groups of pupils at different grade levels are not answering the same attitude questions from the same experiential background. The attitudinal objects of pupils in different grades may not be equivalent. It is, therefore, very difficult to evaluate cross-grade attitude results. However, recognizing the experiential differences, a study was conducted using all of the items on the Grade 4 School Science scale and the equivalent first seven items on the Grades 8 and 10/12 scales. The results are shown in Table 3.17.

Table 3.17: School Science Scale: Statistics Across Grades

Grade	Sample N	Number of Items	Mean	Standard Deviation
4	2971	7	3.72	.82
8	1022	7	3.21	.40
10	974	7	3.39	.74
12	1150	7	3.38	.79

The mean and standard deviation values in the table resulted from calculating an individual's score as the average of the seven weighted item values. Scores, therefore, ranged from one to five, with a theoretical mid-point of three. Of interest is the high mean value at Grade 4 and the relatively large drop in the mean and the reduced standard deviation at Grade 8. This change is worthy of speculation and further research. Also of interest is the increase in mean scores from Grade 8 to Grade 10 and 12 with no difference between Grades 10 and 12. Further analyses of other upper grade differences will be discussed in Chapter 5.

Table 3.18: Grade 4, Interest in Science Topics, Sex-Related Differences

Science/Topic	Gender	Response Categories Not Interested	Somewhat Interested	Very Interested
Biology				
1X.* How Birds Live	B	28	51	21
	G	11	52	37
1Y. How Flowers Grow	B	49	40	11
	G	19	50	31
1Z. How Young Animals Live	B	22	46	32
	G	7	39	54
Physical Sciences				
2X. Why Things Rust	B	42	37	21
	G	49	36	15
2Y. How Magnets Work	B	13	37	50
	G	28	42	30
2Z. Why Something Burns	B	34	40	26
	G	40	45	15
Earth/Space				
3X. Why Rivers Flood	B	31	39	30
	G	25	46	29
3Y. Why Volcanoes Blow Up	B	10	26	64
	G	19	32	48
3Z. Why Stars Shine	B	20	33	47
	G	10	39	51
Technology				
4X. How Airplanes Fly	B	12	26	62
	G	38	38	24
4Y. How An Electric Light Works	B	21	42	37
	G	28	46	26
4Z. How a Television Works	B	17	29	54
	G	26	40	34

* Number refers to statement number on each form; letter refers to the form on which the statement appears.

3.9 Interest in Science Topics

A search was made, primarily through the British Columbia science curriculum guides and related texts, in order to identify and select topics in science for the purpose of having pupils judge their relative interest. Twelve topics were chosen, with three classified under each of the following headings: Biology, Physical Science, Earth/Space Science, and Technology. One topic in each of the four categories was included at the beginning of each Grade 4 achievement form. The claim is not made that the topics are necessarily representative of the British Columbia curricular emphasis or that the topics are representative within the four broad science areas. It is hoped that primary and other teachers may use the short questionnaire as a model for developing their own interest questionnaires and, if possible, that the knowledge, principles, and processes of science may be taught through the content of their pupils' expressed interests. Table 3.18 shows the percentage responses of boys and girls to the various topics organized in terms of the four science areas. For simplicity in reading, the largest percentages in the extreme response categories are underlined.

There are, of course, no solid conclusions that can be derived from the response data. There are, though, some evident sex-related differences. The "Very Interested" column shows that girls express a 16 to 22% greater interest than boys in each of the Biology topics. Although interest is generally low in Physical Science, boys expressed from 6 to 20% greater interest than girls in the topics. Similarly, the boys expressed from 11 to 30% greater interest than girls in the Technology topics. Sex-related differences in Earth/Space are varied, although the topics received some of the highest interest ratings.

CHAPTER 4

GRADE EIGHT RESULTS

John Sheppy and Hugh Taylor

This chapter reports and interprets the achievement and affective results obtained by surveying Grade 8 pupils. Grade 8 pupils were surveyed in order to assess the achievement of those who had completed elementary school.

Three Science Assessment instruments (Forms 8X, 8Y, and 8Z) were prepared. Each form had the following components:

- eight Background Information questions which provide the basis for sub-groups used later in this chapter
- two affective scales (10 to 13 items each) which were different on the three forms, thereby providing six scales
- forty multiple-choice achievement items which were different on each form

The achievement items were designed to fit Table 2.5, the table of specifications for the Grade 8 Science Assessment. Each domain and each objective were equally represented on each form.

Although for purposes of the Assessment it was not necessary that the forms be balanced in terms of average difficulty of items, for face validity purposes an attempt was made to keep the forms at approximately equal difficulty levels.

The domain and objective emphases were determined by the Advisory Committee, in consultation with the Contract Team, as being an appropriate reflection of the science which should be taught in the intermediate grades in elementary school. Sets of expanded objectives were written to define each of the objectives on the table, and items were chosen or written to assess these expanded objectives. All expanded objectives and items were reviewed twice by the Advisory Committee and by two different Review Panels. Revisions were made as required. All items which were used were considered to be valid for British Columbia pupils by these Panels. The content of the Grade 8 curriculum was not considered in the preparation of items, except where there was overlap with previous grades. The pool of items generated was approximately three times as great as the number of items used.

Twenty-five items from the 1978 Science Assessment were used unaltered. These items are called Change Items, and are the subject of additional analysis in Section 4.6.

As often as possible, when items were constructed with drawings or prose selections as part of the question, the Contract Team tried to utilize reproductions of materials likely to be at the level found in elementary school libraries or classrooms. Sometimes the material was chosen from science textbooks not in use in British Columbia and sometimes from common reference books. This was an attempt to keep the information contained in Science Processes or Higher Level Thinking items at an appropriate level. Since these materials were sometimes ambiguous and since not all reproduced well, the Interpretation Panel was sometimes critical of the graphics on the achievement instruments.

The Grade 8 Interpretation Panel rated pupil achievement on each item and on each objective. Panel members individually examined each item and set percentage levels of performance they judged to be acceptable and levels they felt were desirable. They then, individually, compared the pupils' performance with these levels. Consensus procedures were used to produce Panel ratings.

Panel members used the following five-point scale:

Strong	ST
Very Satisfactory	VS
Satisfactory	S
Marginal	M
Weak	W

These ratings are not based upon objective criteria but on the Panel members' expectations for Grade 8 pupils and Panelists' assessment of the importance of the items.

Appendix F contains all items arranged by domain and objective, shows the provincial percentage of pupils who chose each option and gives the Interpretation Panel ratings based on the above scale.

4.1 Description of the Pupils Who Wrote the Assessment Instruments

Those eligible to write the Grade 8 Science Assessment instruments were all of the Grade 8 pupils in 63 British Columbia school districts and all Grade 8 pupils from selected schools in the 12 largest districts. The number of pupils who did write was 29 699 which was 91% of the eligible pupils or 74% of all Grade 8 pupils. The number of pupils who wrote each of the forms was 9917 for Form X, 9917 for Form Y, and 9865 for Form Z.

Of these pupils, nearly 50% were boys and 48% girls; over two percent failed to indicate their gender. The median age was 13.9 years, and the age distribution is shown in Table 4.1. Fourteen percent learned to speak English as a second language and six percent still speak their first non-English language most often in their homes. Since Grade 4, 17% of the pupils had moved into their present district from another British Columbia school district, eight percent had moved in from another province, and three percent emigrated from another country. Thirteen percent, probably in semestered schools, had already successfully completed Science 8. Table 4.2 shows the percentages of pupils receiving Science 8 instruction according to different time-table patterns.

Table 4.1: Ages of Pupils Writing Grade 8 Assessment Forms in 1978 and 1982

Age in Years	Percent of Pupils 1978	1982
15 or older	7	6
14	34	33
13	58	58
12 or younger	1	3

Table 4.2: Percentages of Pupils Responding by Timetable Pattern

Pattern	Percent
Full 10-month course	63
Semester Course	29
Quarter System Course	6
Other	1

4.2 Domain 1--Science Processes

The domain of Science Processes was assigned 30% of the assessment items. Because of the need to sample a wider range of outcomes, not because it is of less importance, the Science Processes domain has fewer questions at Grade 8 than at Grade 4. The Elementary Science Curriculum Guide, Grades 1-7 (1981) lists and describes 12 processes as sub-goals of Goal B of the program. Goal B states "The Elementary School Science Program should develop in students the processes and skills of science" (page 7). The decision was made to assess only four of the processes. Those chosen were: classification, communication, interpreting data, and identifying and controlling varibles. Classification and communication were also assessed at the Grade 4 level, but only four common items were ultimately used in both grades. Interpreting data, and identifying and controlling variables were also assessed in Grade 12, but only two common items were used in both grades. It was decided not to assess the process of quantification, although it is extremely important, because there were 21 measurement items (of which nine dealt with metric units) in the 1981 Mathematics Assessment, and there seemed to be no need for duplication. The Mathematics Assessment Interpretation Panel had rated the Measurement domain in Grade 8 as "Marginal".

In contrast to the Grade 4 level, examination of standardized tests and the relevant literature often provided the Contract Team with usable items or models for the construction of original items except that the range of classification items was limited so that some new types of items were created for assessing this process.

In writing expanded objectives, the Contract Team found that clear lines of demarcation could not always be drawn between the processes defined in the curriculum guide. It was also impossible to establish a clear boundary between critical thinking and some of the processes. This problem has been discussed more fully in Section 3.2.

4.2.1 Classify

The Elementary Science Curriculum Guide, Grades 1-7 (1981) defines classification as "the organization of materials, events and phenomena into logical groupings. At first, classification is a sorting process;.... Later, the student will develop multi-stage systems to categorize rocks, trees, etc." (page 7). The measurement format--pencil and paper, multiple choice, black on white--restricted what could be done. Pictures, illustrations, or familiar objects that all pupils could identify had to be used. Some of the simpler classification skills are described in Section 3.2.2 of the Grade 4 discussion. The type of item, in which attributes of a class are inferred from sets of examples and non-examples and then used to identify a new member of the class, proved useful at both grade levels, and had been used in previous assessments. This ability to infer, like all classification sub-skills, when it is removed from the content of real world objects, often seems to be more a matter of intelligence or logic than of science. In fact, the thinking involved is a core strategy in classification and concept formation. Item Y29 is such an item, and was also used at Grade 4 and in the 1978 Assessment.

The measurement format made it impossible to require pupils to develop multi-stage systems, but items were created to assess the abilities of pupils to use the systems developed by others. These systems included tree diagrams and dichotomous keys. Question Z15 (see Appendix F) illustrates the type of item constructed to assess the use of a dichotomous key. On this and on the other "keying-out" items (X09 and Y27) pupils who could not use the key seem to have chosen one attribute and selected as their answer the first mention of this attribute (e.g. the first blond mentioned in X09 was by far the preferred incorrect choice).

Table 4.3 summarizes the provincial results and the Interpretation Panel ratings for this objective. The pupils' results on the objective of Classify were considered to be "Very Satisfactory".

Table 4.3: Provincial Results for the Grade 8 Objective Classify

Item No.	Description	Percent Correct	Panel Rating
1.1.01(X09)	Uses dichotomous key	68	S
1.1.02(X24)	Deletes by stated attribute	86	VS
1.1.03(X29)	Recognizes and applies class rule	57	M
1.1.04(Y27)	Uses dichotomous key	50	S
1.1.05(Y29)	Recognizes and applies class rule	65	VS
1.1.06(Y34)	Recognizes and applies class rule	83	ST
1.1.07(Z10)	Recognizes basis for sorting	32	W
1.1.08(Z15)	Uses dichotomous key	72	VS
1.1.09(Z20)	Recognizes and applies class rule	87	ST
	Mean Percent Correct Overall Rating	66.6 Very Satisfactory	

Pupils seemed to have difficulty on item Z10 either in understanding the tree diagram or in identifying the basis for subdivision into groups. In the much simpler situations in Grade 4, recognition of the basis for classification was not strong. These results indicate that teachers should be giving pupils more opportunities to identify the attributes used by others to separate objects into classes. These opportunities should include, but not be restricted to, identifying the critical attributes used in conventional classifications (e.g. given specimens, identify a characteristic which separates pine trees from other conifers).

4.2.2 Communicate

In Section 3.2.3, the Contract Team identified methods in which scientific information is communicated to and from pupils, and discussed the limitations which the Assessment format imposed on the measurement of communication skills. It is stressed again that measurement could only take place with respect to pupils' reception of communications, not their initiation of them.

Table 4.4 presents the provincial results and the Interpretation Panel ratings for the objective Communicate. The overall performance was considered to be "Very Satisfactory", with two items being rated as "Strong" and three as "Very Satisfactory".

Table 4.4: Provincial Results for the Grade 8 Objective Communicate

Item No.	Description	Percent Correct	Panel Rating
1.2.01(X14)	Uses symbols to read map	48	M
1.2.02(X36)	Reads and interprets graph	72	VS
1.2.03(X38)	Interprets picture	64	S
1.2.04(Y11)	Recognizes correct graph	77	VS
1.2.05(Y15)	Selects key idea in scientific prose	67	VS
1.2.06(Y40)	Selects best diagram of a description	76	ST
1.2.07(Z05)	Interpolates from graph	63	S
1.2.08(Z06)	Extrapolates from graph	43	M
1.2.09(Z22)	Selects best diagram of a description	87	ST
	Mean Percent Correct	66.3	
	Overall Rating	Very Satisfactory	

The item which dealt with map reading (X14) was poorly done by many pupils. The map was justly criticized for lack of clarity of reproduction (the essential features of the map were not obscured). The three items in which pupils indicated understanding of prose description were judged to have been well done although the preferred incorrect answer in Y15 (shown below) may indicate that, despite directions, many children assume that the first true option is the best option in responding to an item. Pupils did well on the two graphing items which required the use of only data points (X36 and Y11). Their performance on interpolation was weaker and even more so on extrapolation, although none of the options provided in the extrapolation item (Z06) was quite right. Although the Grade 4 Interpretation Panel felt that pupils' graphing skills were weak, this was not a concern of the Grade 8 Panel.

4.2.3 Interpret Data

The usual data interpretation situation is that pupils are given a specimen, specimens, or a situation to observe, or are given an experimental situation where changes are observed or measured. From the observations which they themselves collect, the pupils then generate a conclusion or interpretation. Such data often contain ambiguities. Obviously, the assessment format precluded the use of such situations. Data had to be presented in concise forms and the pupil had to be presented with alternative interpretations from which to choose. Time limitations for children in writing the instrument meant that the data presented had to be relatively simple. When qualitative data were presented, they had to be expressed in a few short sentences, and quantitative data were restricted to a few numbers. The need for brevity and clarity, neither of which is a characteristic of data from real observations or experiments, created a certain artificiality in items for data interpretation.

Y15 When large amounts of warm water are dumped into a river, the river itself is heated. The temperature of the water may be raised only a few degrees. Yet these few degrees can change the animal and plant life in the river. Heat causes a loss of oxygen in the water. Fish to longer do well and some kinds die. Without enough oxygen, bacteria in the river cannot break down waste matter. The river is no longer clean.

What is the MAIN IDEA in this paragraph?

Heat causes water to lose oxygen.	16
Fish and bacteria do not do well without oxygen . . .	7
Some fish cannot survive in warm water.	4
Large amounts of warm water can be dangerous to life in rivers.	68*
I don't know.	4

* correct response

As mentioned earlier, it is not always possible to draw clear lines between processes, and one such example would be in the use of graphs. Is extrapolation on a graph a communication or data interpretation skill? This Assessment has chosen to classify it as a communication skill.

The items generated fall into two groups. First, there are those items where data were presented and the pupil was required to select an interpretation consistent with the data. Data were presented in the form of maps (X04, X05), a table (Y08), a prose passage (Y22), and a diagram (Z04). The remaining items asked pupils to address some of the problems which arise in the choice and use of data. Pupils were called upon to recognize that a statement is one of observation rather than an interpretation, to choose relevant data from a data pool, to use sample data to make an overall estimate, and to recognize the need to replicate in order to validate conclusions.

Table 4.5 presents the provincial results and the Interpretation Panel's ratings for the items related to this objective. The overall rating for the objective was "Satisfactory".

Table 4.5: Provincial Results for the Grade 8 Objective Interpret Data

Item No.	Description	Percent Correct	Panel Rating
1.3.01(X04)	Correlates information from two maps	61	VS
1.3.02(X05)	Correlates information from two maps	41	M
1.3.03(X26)	Recognizes an observation	71	VS
1.3.04(Y08)	Identifies trend from table	65	S
1.3.05(Y22)	Selects best interpretation	81	ST
1.3.06(Y24)	Uses average value of data	26	W
1.3.07(Z04)	Interprets diagram sequence	31	S
1.3.08(Z19)	Chooses appropriate data	63	S
1.3.09(Z32)	Recognizes need to replicate	65	S
	Mean Percent Correct	55.9	
	Overall Rating	Satisfactory	

Item X04 (see Appendix F) illustrates some of the points already made. It presents real ecological data from an Environment Canada publication. However, the data had to be simplified considerably to enable pupils to handle the item. Even so, the data can be ambiguous. Pupils have to recognize that option B is better than option C, because, while some of the Garry Oak trees are found in the 690-909 mm rainfall region, much of this region is devoid of the Garry Oak. As in most data interpretation situations, the thinking is complex.

The skill involved in Item Y24 was considered by the Interpretation Panel to be worthwhile, but it is obvious that few pupils have experience in sampling populations. Panel members felt that the reference to Mt. St. Helens in Item Z04 was not helpful, and may have caused pupils to answer on the basis of their knowledge of Mt. St. Helens rather than by attempting to interpret the diagrams. The quality of reproduction of these diagrams was also criticized.

4.2.4 Identify and Control Variables

That part of experimental design which involves the creation of a hypothesis, the identification of manipulated (independent) and responding (dependent) variables, and the recognition and control of other relevant variables is central to experimentation and so to science. The Contract Team, the Advisory Committee, the Review Panels, and the Interpretation Panel were unanimous in considering the process Identify and Control Variables as one of the chief objectives of elementary school science instruction. It was, however, agreed that the terminology used above may not have been taught or stressed. Therefore, in constructing the items, synonymous terms or descriptions were used for the terms "manipulated", "responding" and "variable". Model items for this process appeared fairly frequently in the literature examined, but were usually designed for grade levels above Grade 8. The Contract Team wishes to acknowledge the help obtained from the Test of Integrated Process Skills by F. Gerald Dillashaw and James R. Okey, who permitted the Team to adapt several TIPS items for this section of the achievement instrument.

Table 4.6 shows the provincial results and the Interpretation Panel ratings for the items of this objective. The Panel gave this objective an overall rating of "Weak". It was one of only two objectives rated "Weak" in the interpretation process at all three levels. Only one question on this objective received a rating as high as "Very Satisfactory".

Table 4.6: Provincial Results for the Grade 8 Objective Identify and Control Variables

Item No.	Description	Percent Correct	Panel Rating
1.4.01(X06)	Identifies responding variable	77	VS
1.4.02(X07)	Identifies controlled variables	45	M
1.4.03(X16)	Knows meaning of hypothesis	41	W
1.4.04(Y04)	Selects suitable hypothesis	29	W
1.4.05(Y05)	Identifies manipulated variable	56	S
1.4.06(Y06)	Identifies responding variable	35	S
1.4.07(Z21)	Selects valid criticism of experimental design	41	M
1.4.08(Z30)	Identifies manipulated variable	40	M
1.4.09(Z31)	Selects valid criticism of experimental design	43	M
	Mean Percent Correct Overall Rating	45.2 Weak	

In order that experimental situations be adequately described, it was necessary to include a substantial quantity of prose reading. To lessen the effect this had on pupil time, items were usually designed so that two or three independent questions were asked about each description. Item X16 was used to test pupils' understanding of the important term "hypothesis". The incorrect and "I don't know" responses indicate that the term is not being adequately taught. In fact, the high percentage of "I don't know" responses throughout the items for this objective is a cause of concern since it indicates many pupils are not receiving instruction on this objective. Items Z30 and Z31 are shown below, and illustrate several of the points just made. They also illustrate a common fault in pupil-designed experiments, namely the failure to identify a single responding variable.

Sue wanted to find out what might affect the length of bean seedlings. She placed a bean wrapped in moist tissue paper in each of TEN identical test tubes. She put FIVE test tubes in a rack in a sunny window. She put FIVE test tubes in a rack in a dark refrigerator. She measured the length of bean seedlings in each group after one week.

Z30 Which of the following OTHER factors did Sue test for their effect on the length of the bean seedlings?

Moisture and length of test tube	9
Light and temperature	42*
Light and amount of time	14
Temperature and moisture	12
I don't know	23

Z31 Sue found that the seedlings grew better in the rack on the sunny window. Why might Michael criticize her experiment?

There is no reason to criticize her experiment.	27
She should have put different amounts of water in the test tubes.	10
She cannot tell if the better growth is a result of temperature or of light or both.	42*
She did not need to use so many test tubes.	8
I don't know.	12

* correct response

4.2.5 Summary and Recommendations

The Interpretation Panel felt that it was unable to give an overall domain rating because its assessment of achievement in the separate objectives ranged from "Very Satisfactory" to "Weak". It made the following comment:

> "Although classifying and communicating were very satisfactory, the area of scientific method (i.e., Identify and Control Variables) was very weak. As this is the basis of all science, there should be concern because something in the classroom is not being done."

The Contract Team concurs with the Interpretation Panel in its recommendations that:

- in-service workshops in scientific method be provided for teachers
- teachers use many more classroom activities which require controlled experimentation

The Contract Team adds that it is essential that pupils learn to design, as well as to perform, controlled experiments.

4.3 Domain 2--Knowledge--recall and understand

The B.C. Elementary Science Curriculum Guide, Grades 1-7 (1981) states Goal C as follows:

> The Elementary School Science Program should develop in students scientific knowledge. The student should demonstrate and apply knowledge of the following:
>
> - facts, generalizations, concepts, principles, and laws;
> - scientific vocabulary;
> - relationships between various scientific disciplines;
> - the history, philosophy, and nature of science;
> - the application and limitations of science in the practical world. (page 9)

For the purpose of this Assessment, items relating to the pupils' use of knowledge by applying it to new situations were placed in Domain 3--Higher Level Thinking. Domain 2 was designed to test pupils' recall and understanding in three areas:

- knowledge of basic scientific facts, concepts, generalization, and vocabulary

- knowledge of ways in which science is applied, which is distinct from the intellectual process of applying one's own knowledge, and of the nature of science
- knowledge of safety procedures

This domain was alloted 48% of the items in the Grade 8 Assessment, not because it was held as more important than the Science Processes domain, but because of the range of knowledge available for assessment.

4.3.1 Biological, Physical and Earth/Space Science Concepts

Thirty-three items, just over one-fourth of the total, were used to assess achievement of knowledge of science facts, concepts, principles, and vocabulary--the traditional area for objective measurement. Twelve of the items were change items which had been used in the 1978 Science Assessment; some others came from assessments elsewhere. Only about one-third of the items were newly constructed. Two of the items were also used in Grade 4 and another two in Grade 12.

The 33 items were distributed among the different science content areas so that 12 related to each of biological science and physical science, and nine related to earth/space science. Except for change items, the content of any item which was used in this part of the Assessment appears in at least two of the three alternative programs at the intermediate level. For many of the items, the content is in all three of the programs.

Table 4.7 summarizes the Interpretation Panel's ratings of items for this objective. The mean percent correct for the 33 items was 53.1%, and the overall rating for the knowledge of concepts objective was "Satisfactory".

Table 4.7: Summary of Panel Ratings of Items in the Grade 8 Objective Biological, Physical and Earth/Space Science Concepts

Rating	Number of items
Strong	0
Very Satisfactory	6
Satisfactory	13
Marginal	8
Weak	6
Mean Percent Correct	53.1%
Overall Rating	Satisfactory

Because of the length of such a table and because of the specificity of the items, a table similar to that presented for earlier objectives will not be used. However, because it may interest teachers, Table 4.8 shows the numbers and ratings of the items by science content area.

Table 4.8: Grade 8 Pupils' Achievement in Biological, Physical and Earth/Space Science Content Areas on Objective 2.1

Biological Science			Physical Science			Earth/Space Science		
Item No.	Percent Correct	Panel Rating	Item No.	Percent Correct	Panel Rating	Item No.	Percent Correct	Panel Rating
X01	56	S	X10	42	M	X11	35	W
X15	22	M	X17	70	VS	X19	54	S
X31	44	M	X34	59	S	X21	40	S
X37	72	VS	X35	42	M	Y25	43	W
Y01	78	VS	Y02	68	S	Y26	78	VS
Y13	63	S	Y18	38	W	Y33	65	S
Y28	38	W	Y23	54	S	Z03	45	W
Y30	52	M	Y39	43	S	Z11	62	S
Z16	74	VS	Z18	49	M	Z14	34	W
Z23	63	S	Z33	49	M			
Z26	56	M	Z35	65	VS			
Z36	43	S	Z40	58	S			
Mean Percent Correct	55.1			53.1			50.6	

This table shows that the assignment of Interpretation Panel ratings for biological and physical science items are similar, but that more earth/space science items were rated as "Weak". Four of the six "Weak" ratings for the objective were given to earth/space science items. This may indicate that elementary teachers are giving earth/space science less emphasis than other science areas.

In biological science, pupil achievement was highest on items relating to parts of plants or animals and their functions, and to the single item on reproduction (Z16). Despite its importance for our world and in biology, and despite the references to it in most treatments of plant life, pupils' performance on the two items (X31, Z26) on photosynthesis was rated "Marginal". Two items (X01, Y28) asked about nutrition. The high percentage of pupils choosing the incorrect answer, a glass of milk, to X01 may indicate that these pupils have learned about good nutrition but not about the functions of nutritional components.

From the physical science items, few patterns could be seen. The three programs show a good deal of variability in the physical science topics at each grade level and in their total coverage. This variability presented some measurement problems since a pupil had to be capable of answering an item correctly regardless of the program utilized. Responses to the two items on weight and gravitation (Y18, Z40) do not give confidence that these basic topics are being well taught. It is of concern that one-third of the children would give the answer 120°C for Item X10, since it indicates that they see no relationship to their everyday experience of mixing hot and cold water, and since water of temperature 120°C is meaningless in any situations children know. Such pupils failed to ask themselves if the answers they gave were reasonable in terms of the world they know.

Pupil performance in the earth/space science area causes concern. Geology items (X11 (see below), X21, Y25, and Z14) were particularly poorly answered, and the answers to Item X11 indicate a real need to stress cycle concepts. Except for Z03 (the astronomy related item), Items X19, Y26, Y33, and Z03, were answered reasonably well. Planetary astronomy is a topic about which many intermediate pupils get excited, and in the last few years it has received much publicity as a result of space probes. It is likely that many teachers use science-related current events in their instruction.

X11 The water that flows into the ocean as rivers

all comes from town and city sewage disposal plants. .	3
all comes from lakes at the heads of the rivers. . . .	47
reaches the river by many paths through the air, over the land surface, or underground	35*
was lifted from underground caverns to the surface of the earth by gravity	2
I don't know	12

* correct response

4.3.2 Applications of Science (Technology) and of the Nature of Science

This objective combines two sub-objectives which both relate to the interaction of science and society, a theme which has become important in science education in recent years. The ways in which science affects society are indeed complex, but knowing some practical effects of science is the simplest level of understanding. Six items were used to assess this area of knowledge. Two items asked for knowledge of public health measures, two asked for knowledge about everyday uses of science, and two related to pollution, a theme of much current concern.

The other sub-objective related to facets of the scientific enterprise itself. Four items were developed about the nature of scientific knowledge and two about the appropriate scientific behavior in a situation.

Table 4.9 presents the provincial results and Panel ratings for this objective, separated into the two sub-objectives. The Interpretation Panel rating for the objective was "Marginal", and the item ratings indicated that the Panel judged pupil achievement to be poor in both areas. The Panel stressed the need for more teaching of the applications of science, and felt that, in teaching concepts, teachers often fail to show how these concepts are applied in day-to-day life outside of school.

Item X08 illustrates some interesting features. It is unlikely that flouridation has appeared as a formal topic in the science program for many pupils. It may have appeared incidentally when teeth were being discussed. However, nearly two-thirds of the pupils have knowledge about it. Probably, this knowledge has been obtained from their own experience or from the media.

X08 Which ONE of the following substances is added to drinking water to help prevent tooth decay?

Fluoride	67*
Chlorine	15
Calcium	8
Iodide	9
I don't know	1

* correct response

Table 4.9: Provincial Results for the Grade 8 Objective Applications of Science (Technology) and the Nature of Science

Item No.	Description	Percent Correct	Panel Rating
Applications of Science (Technology)			
2.2.01 (X08)	Knows some public health measures	65	M
2.2.03 (X22)	Knows some wastes not biodegradable	54	M
2.2.05 (Y16)	Knows factors causing water pollution	42	W
2.2.07 (Y35)	Knows public health measures	64	S
2.2.10 (Z17)	Knows principles of thermal insulation	47	S
2.2.11 (Z28)	Knows sources of useful products	49	M
	Mean Percent Correct	53.5	
The Nature of Science			
2.2.02 (X12)	Distinguishes between observations and explanations	52	M
2.2.04 (X30)	Knows nature of scientific laws	34	M
2.2.06 (X31)	Knows scientific knowledge is cumulative	66	S
2.2.08 (Y36)	Knows scientists seek to explain anomalies	41	M
2.2.09 (Z07)	Knows scientific knowledge is incomplete	41	M
2.2.12 (Z39)	Knows results should be reported accurately	44	M
	Mean Percent Correct	46.3	
	Mean Percent Correct on Objective	49.8	
	Overall Rating	Marginal	

The other public health item regarding the decline of polio (Y35) was also correctly answered by nearly two-thirds of the children. Despite current concerns, the two items on pollution (X22, Y16) were poorly answered. Considering the importance of wheat to Canada's history and economy, the failure of more than half of the pupils to know that flour comes from seeds underlines the Panel's concern about failure to teach applications.

Assessment item results on the nature of science seem to indicate that teachers are giving little priority to instruction in this area. Formal lessons about the nature of science are probably not appropriate in elementary school, but day-by-day opportunities arise in the context of teaching where incidental instruction can, and should, occur. The only item that was at all well-answered (Y31) related to the cumulative nature of science. Only half of the pupils could distinguish a theoretical statement from a set of observational statements (X12), only one-third knew what a scientific law is (X30), and at least one-fourth believed that there are exceptions to scientific laws (Y36). Nearly 60% of the pupils seemed to think that there are areas of science which are completely understood (Z07). Item Z39 asked pupils how they should behave in a situation where their observations do not fit the printed information available to them. The incorrect responses indicate the faith children have in the printed word. Fifteen percent of the pupils were prepared to report data contrary to their own findings, and 30% were prepared to report that they had made an error and would follow the reasonable course of redoing the experiment. Interpretation Panel members' comments on the quality of the item ranged from "very poor" to "very good".

4.3.3 Safety Procedures

All groups concerned felt that knowledge in the area of safety was a high priority. Interpretation Panel members had high levels of expectation for pupils, and many rated the desired level of knowledge at 100%. One member's comment was, "standards in this area must be very high and constantly reviewed." Readers of this section are reminded that the Grade 8 Assessment dealt only with knowledge pupils might be expected to have at the end of Grade 7 and that, by the time the instruments were written, pupils should have had additional Grade 8 safety instruction. Twelve items were asked about safety procedures. Considering the scope of content available, the sampling of safety knowledge was more complete than the sampling of achievement in any other area. Five of the items were also used at the the Grade 4 level, and three were used at the Grade 12 level. The comparative performances on these overlap items are shown in Tables 4.17 and 5.25. The Interpretation Panel rated only five items as "Satisfactory", and gave the whole objective a "Weak" rating. Table 4.10 summarizes the provincial data and the Panel ratings.

Table 4.10: Provincial Results for the Grade 8 Objective Safety Procedures

Item No.	Description	Percent Correct	Panel Rating
2.3.01 (X03)	Knows procedures for broken glass	77	S
2.3.02 (X18)	Knows how to test odours	58	M
2.3.03 (X28)	Knows how to test hot metal	51	M
2.3.04 (X39)	Knows procedures if acid splashed	78	M
2.3.05 (Y07)	Knows procedures in case of fire	83	M
2.3.06 (Y10)	Knows action in hazardous situation	35	W
2.3.07 (Y14)	Knows to wash after procedures	72	S
2.3.08 (Y20)	Knows procedures if acid splashed	84	S
2.3.09 (Z01)	Knows not to taste unknowns	79	S
2.3.10 (Z13)	Knows hazard of lye or drano	57	M
2.3.11 (Z27)	Knows animal hazards	79	S
2.3.12 (Z34)	Knows procedures in heating test tube	34	W
	Mean Percent Correct Overall Rating	65.6 Weak	

It is encouraging to note in Table 4.17 that there is substantial improvement between Grade 4 and Grade 8 on the items dealing with clothing on fire (Z13) and the hazards of lye or drano, although the Grade 8 Panel still felt the knowledge of pupils was inadequate. The knowledge that fires can be extinguished by smothering might become more widespread if fire blankets were more common in schools and pupils were instructed in their use. Items X03 and X28, on broken glass and testing objects for temperature, are discussed in Section 3.3.3.

The two items which dealt with heating liquids, one in a flask (Y10) and the other in a test tube (Z34), indicated poor understanding of proper laboratory procedure and poor understanding of the explosive power of steam. The two similar items which dealt with acid splashes indicated that about 80% of the pupils knew the appropriate action to take, but the need to flood affected parts with water is such an important action that all children should know what to do, even though few pupils will work independently with acids until junior secondary school.

4.3.4 Summary and Recommendations

The Interpretation Panel did not rate this domain because they felt that such a rating would obscure the differences which existed among the performances on the objectives. Even within the knowledge of science concepts objective which it rated as "Satisfactory", the Panel felt there was great variety of performance, but made no recommendations regarding this objective.

The Contract Team concurs with the Interpretation Panel's recommendations that:

- in their teaching of concepts, teachers stress the everyday applications of scientific knowledge
- elementary school teachers give greater stress to knowledge of safety procedures
- knowledge of safety procedures be stressed in the training of teachers

This last recommendation results from an analysis of the teacher questionnaire data reported in Chapter 5.

The Contract Team further recommends that:

- elementary and junior secondary science teachers give greater emphasis to earth science concepts in their teaching
- teachers use the incidental opportunities which arise in the teaching of science concepts and processes to explicitly teach pupils about the nature of science, e.g. the primary distinction between observation and inference or the need to report data honestly

4.4 Domain 3--Higher Level Thinking

For the purposes of this Assessment, Domain 3 consisted of two objectives. Apply Biological, Physical and Earth/Space Science Concepts, part of Goal C in the Elementary Science Curriculum Guide, Grades 1-7 (1981), was the first objective. The second objective was those aspects of Goal D which are amenable to objective testing. Goal D states "the Elementary School Science Program should develop in students creative, rational and critical thinking" (page 9). Because of the Assessment format, no attempt was made to assess creative thinking. By the end of the intermediate grades, pupils were expected to have a fund of scientific knowledge which they could apply and to have had critical and rational thinking experiences. Twenty-two percent of the assessment items (27 items) were used for measurement in this domain. Few suitable questions for pupils at the Grade 8 level were found in the literature of science testing. Most of the examples relevant to this domain were for senior secondary or older students. Almost all of the items used had to be constructed for this Assessment.

4.4.1 Apply Biological, Physical and Earth/Space Science Concepts

Application involves using the knowledge one possesses in a new situation. Two difficulties arise when one seeks to evaluate application. They are:

- pupils may not have the requisite knowledge
- the situation may not be new to the pupils, as they may have encountered the particular application previously, and so answer the question on the basis of knowledge

Thus, correct answers may be given either because pupils correctly apply knowledge or because they recall the correct answer, and incorrect answers may result from faulty application of knowledge or from failure to possess the requisite knowledge. An attempt was made to provide true application items for the majority of pupils, but it did not always seem to have succeeded. Item X40 illustrates some of the points discussed. In order for this item to be truly an application item, pupils would have to know what an amphibian is and the typical life-cycle of an amphibian, but not previously know that salamanders were amphibians. It would also help to know what reptiles are and their typical life-cycle. If pupils know the life-cycle of salamanders, the question becomes a knowledge level item. Incorrect responses to this item are probably more indicative of the lack of the requisite knowledge of the amphibian and reptile classes and their life-cycles than of failure to apply knowledge.

X40 A lizard is a reptile and a salamander is an amphibian. Which of the following is true:

Lizards do not lay eggs.	7
Lizard eggs hatch into tadpole-like creatures.	11
Salamander eggs hatch into small salamanders	26
Salamander eggs hatch into tadpole-like creatures. . .	32*
I don't know	22

* correct response

Another interesting example is Item X25, the most poorly answered item for this objective. There might seem to be two relevant scientific principles here--"the speed of light is greater than the speed of sound in a medium" and "sound propagates only if there is a medium". Responses show that nearly half the pupils responded on the basis of the first, ignoring the fact that no medium exists in which the sound could be propagated. The choice of the relevant principle or principles to consider in explaining a scientific situation or solving a problem is an important skill which requires experience and has been little studied.

X25 Suppose that some clear night the moon exploded. Which ONE of the following would happen?

We could see the explosion and hear a terrific noise at the same time.	9
We could see the explosion, but hear no sound.	27*
The sound would reach us before we saw the explosion.	12
We could hear the sound after we saw the explosion. .	45
I don't know.	7

* correct response

Table 4.11 presents the provincial results and Panel ratings for the objective of applying knowledge. The Interpretation Panel rated pupil performance on this objective as "Satisfactory". The Panel felt that some diagrams were unclear, and considered that the latitude which exists in the curriculum allows teachers to omit the study of some of the areas measured from their programs.

The large difference in correct responses to the two food chain items (Y03, Z09) may be partly due to the familiarity of the first situation (cougar, wolf, and deer) and the unfamiliarity of the second (krill, seals, and polar bears), but it is more likely to be due to the difficulty of predicting a second-order change rather than a first-order change. The performance on the electric circuits items may indicate, as some Panel members pointed out, that although units on electric circuits appear in all three alternative programs, few teachers are teaching hands-on electricity units in elementary school. Item Y09 is interesting, more in the reactions it produced in Panel members than for the pupil results. It produced the sharpest division between those who thought it a good item and those who thought it poor. Pupils' failure to answer this item well may result from poor reading comprehension, from ignorance that the sun rises in the east and sets in the west, or from inability to mentally orient themselves and to use directions. The need to use a complex of skills is usual in higher-order thinking situations.

Table 4.11: Provincial Results for the Grade 8 Objective Apply Biological, Physical and Earth/Space Science Conceptes

Item No.	Description	Percent Correct	Panel Rating
Apply Biological Science Concepts			
3.1.01(X02)	Correlates body structure to behavior	72	VS
3.1.05(X40)	Applies knowledge of class characteristics to a species	30	M
3.1.06(Y03)	Predicts the effects of changes in food chain	70	VS
3.1.08(Y12)	Correlates body structure to behavior	46	S
3.1.12(Z09)	Predicts effects of changes in a food chain	37	M
3.1.15(Z29)	Places organ in appropriate body system	77	VS
	Mean percent correct - Apply Biology Concepts	55.3	
Apply Physical Science Concepts			
3.1.03(X25)	Applies knowledge of sound transmission	25	M
3.1.04(X33)	Applies concept of thermal expansion	64	S
3.1.09(Y32)	Applies straight line propagation of light	61	S
3.1.10(Y37)	Applies knowledge of energy forms	47	S
3.1.13(Z24)	Applies knowledge of circuits to predict	49	S
3.1.14(Z25)	Applies knowledge of circuits to predict	32	M
	Mean Percent Correct - Apply Physical Science Concepts	46.3	
Apply Earth/Space Science Concepts			
3.1.02(X13)	Applies knowledge of solar system relationships	34	W
3.1.07(Y09)	Applies knowledge of solar system relationships	29	M
3.1.11(Z09)	Applies knowledge of properties of air	70	VS
	Mean Percent Correct - Apply Earth/Space Science Concepts	44.3	
	Mean Percent Correct for Objective	49.7	
	Overall Rating	Satisfactory	

4.4.2 Use Rational and Critical Thinking

The Elementary Science Curriculum Guide, Grades 1-7 (1981) defines rationality as "the ability to look for natural causes of events" (page 9) and critical thinking as "the ability to identify central issues, to recognize underlying assumptions, and to evaluate evidence. The student should be able to recognize stereotypes and biases, to identify essential, verifiable, and adequate data, and to draw conclusions" (page 9). The Contract Team used these definitions as guidelines in constructing items for this objective. In addition, the statements regarding rational and critical thinking in the Sample Minimal Essential Program of the new curriculum guide were examined for guidance. No items relating to rational thinking survived the item selection process.

Table 4.12 presents the provincial results and the Panel ratings for this objective. The Interpretation Panel rated pupil performance in Use Rational and Critical Thinking as "Marginal".

Unless the range of thinking items was to be severely limited, it was essential that pupils be presented with adequate data about which to think. This necessitated somewhat longer items for this section of the instrument than elsewhere, creating some concern on the part of the Interpretation Panel. Item Z12 illustrates this point. Its purpose was to assess pupils' ability to judge whether or not a conclusion was warranted by evidence presented. Although it had one of the longest prose sections on the test, 64% of the pupils were able to answer it correctly.

Item X32 was somewhat similar. In this item, the most frequently chosen incorrect option illustrates a common fallacy--having determined that a factor is present in all positive cases, one attributes causality to this factor without determining its presence or absence in negative cases.

The items requiring the use of induction (X20) and deduction (Y17) were poorly done. While no one expects pupils to have had formal logical training at this level, teachers ought to be aware that they should help pupils recognize logical errors.

Three items dealt with the use of information in presenting arguments. Item Y38 asked for recognition of an underlying assumption and Items Y19 and Z08 asked for recognition of facts which support, deny or have no bearing on a statement. Both of these skills are important in receiving or communicating information in a discriminating way.

Two items dealt with mathematical relationships. In X27, pupils were expected to recognize that Mercury is about one-third the diameter of Earth and to visually pick out the appropriate circle. The most frequent wrong answer here was the second best choice. Item Z37 confirms previous studies that, despite the work done on ratio and proportion in elementary school mathematics, most pupils of this age do not use proportional reasoning well.

Table 4.12: Provincial Results for the Grade 8 Objective Use Rational and Critical Thinking

Item No.	Description	Percent Correct	Panel Rating
3.2.01(X20)	Uses inductive logic to form conclusion	34	W
3.2.02(X23)	Recognizes class inclusion situations	48	S
3.2.03(X27)	Uses proportional reasoning	59	S
3.2.04(X32)	Selects reason why an inference is unwarranted	51	S
3.2.05(Y17)	Uses deductive logic correctly	37	W
3.2.06(Y19)	Selects data which support, deny or have no bearing on an assertion	34	M
3.2.07(Y21)	Selects reasonable course of action for practical problem	70	VS
3.2.08(Y38)	Selects assumptions which underlie a statement	49	M
3.2.09(Z08)	Recognizes when data support an assertion	56	S
3.2.10(Z12)	Evaluates a conclusion	64	VS
3.2.11(Z37)	Uses proportional reasoning	26	M
3.2.12(Z38)	Selects source of best data	23	W
	Mean Percent Correct	45.9	
	Overall Rating	Marginal	

Item Z38 was designed to measure children's ability to select the best source of information about a relevant problem. The Interpretation Panel was concerned that 15% of the pupils selected testimonials over scientific data. The results of this item, including the "I don't know" response, are confirmatory of those in the Identify and Control Variables section leading one to conclude that many pupils do not have clear ideas of scientific procedures.

4.4.3 Summary and Conclusions

The Interpretation Panel rated pupil performance as "Marginally Satisfactory". The Panel noted the following as possible reasons for poor performance:

- some achievement survey items need improvement, particularly improvement of diagrams and reduction in the reading level required
- the latitude in the curriculum allows pupils to have not studied some of the areas measured
- some pupils may not have reached the developmental level assumed by some of the items
- teaching strategies may be unsatisfactory

The Interpretation Panel recommended that:

- teachers be given more in-service education in teaching higher level thinking skills
- the range of choice in the core curriculum be narrowed
- teachers ensure that all pupils experience the inquiry style of learning

4.5 Overall Results on the Grade 8 Achievement Form

Table 4.13 summarizes the Interpretation Panel ratings for the Grade 8 achievement forms. The Panel felt that there was too much variability in performance on the objectives of two of the domains to give these domains overall ratings. Only two of the nine objectives were rated as "Very Satisfactory", and four received less than "Satisfactory" ratings.

The 1978 report made the comment that, "taken as a whole, the results of the Grade 8 test can be considered to be very encouraging. The evidence indicates that students enter secondary school with well-developed skills in basis processes, and a satisfactory level of understanding of science concepts" (page 76). Although basic processes (Classify, Communicate) are still being very well-developed and knowledge of science concepts is rated "Satisfactory", the 1982 Interpretation Panel expressed great concern over those areas of science instruction which they judged to be "Weak". These areas had not been explored as thoroughly in 1978. Most concern related to the pupils' lack of knowledge of safety procedures and their inability to identify and suggest controls for variables in experimental procedures.

Table 4.13: Summary of Domain and Objective Ratings for Grade 8

Domain or Objective	Frequencies					Mean Percent Correct	Domain or Objective Rating
	ST	VS	S	M	W		
1. Science Processes							
1.1 Classify	2	3	2	1	1	66.6	VS
1.2 Communicate	2	3	2	2	0	66.3	VS
1.3 Interpret Data	1	2	4	1	1	55.9	S
1.4 Identify and Control Variables	0	1	2	4	2	45.2	W
Process Domain	5	9	10	8	4	58.5	No Overall rating
2. Knowledge							
2.1 Science Concepts	0	6	13	8	6	53.1	S
2.2 Applications(Technology)/ Nature of Science	0	0	3	8	1	49.8	M
2.3 Safety Procedures	0	0	5	5	2	65.6	W
Knowledge Domain	0	6	21	21	9	55.1	No Overall rating
3. Higher Level Thinking							
3.1 Apply Science Concepts	0	4	5	5	1	49.7	S
3.2 Use Rational and Critical Thinking	0	2	4	3	3	45.9	M
Higher Level Thinking Domain	0	6	9	8	4	48.0	M-S

4.6 Comparisons with the 1978 Assessment

Twenty-four achievement items which had been used in the 1978 Science Assessment were repeated unchanged, even to the order of the distracters, in the 1982 Assessment. These items, known as change items, were used to compare pupil achievement in the two Assessments. The only differences between the Assessment with respect to these items was that in 1978 the pupils answered questions on a response sheet, while in 1982 they answered directly on the achievement booklets. Tables 4.14 and 4.15 present the comparative results.

Table 4.14: Results on Grade 8 Science Processes Change items in 1978 and 1982

		1978		1982		
1982 Item No.	Description	Percent Correct	Panel Rating	Percent Correct	Panel Rating	Percent Difference (1982-1978)
Science Processes						
1.1.05(Y29)	Recognizes and applies class rule	68	VS	65	VS	-3
1.2.02(X36)	Reads and interprets graph	67	VS	72	VS	+5
1.2.03(X38)	Interprets picture	58	S	64	S	+6
1.2.04(Y11)	Recognizes correct graph	73	VS	77	VS	+4
1.2.07(Z05)	Interpolates from graph	66	S	63	S	-3
1.2.08(Z06)	Extrapolates from graph	43	S	43	M	0
1.4.04(Y04)	Selects suitable hypotheses	35	S	29	W	-6
1.4.05(Y05)	Identifies manipulated variable	56	S	56	S	0
1.4.06(Y06)	Identifies responding variable	37	S	35	S	-2
Mean Percent Correct		55.9		56.0		+0.3
Standard Error of the Mean		0.1		0.3		

Table 4.14 shows that average performance on the Science Processes items has not significantly changed since 1978. The one substantial downward change (Y04) is in the Identify and Control Variables objective. Substantial upward shifts are evident in the area of graphing.

Average performance on the knowledge items is slightly better in 1982 than in 1978. Performance on two of the safety items has not changed, but, because of the increasing need to stress safe procedures, the Interpretation Panel's standards are different. Performance on the third safety item (Z34) has shown improvement, although it is still weak.

Table 4.15: Results of Grade 8 Knowledge Change Items in 1978 and 1982

1982 Item No.	Description	1978		1982		Percent Difference (1982-1978)
		Percent Correct	Panel Rating	Percent Correct	Panel Rating	
Knowledge						
2.1.02(X10)	Knows temperature of mixtures	47	W	42	M	-5
2.1.05(X17)	Knows speed is distance/ time	68	S	70	VS	+2
2.1.08(X31)	Knows photosynthetic process	42	M	44	M	+2
2.1.11(X37)	Knows functions of plant parts	71	S	72	VS	+1
2.1.13(Y02)	Knows magnets orient on earth	65	S	68	S	+3
2.1.18(Y26)	Knows cause of year	75	S	78	VS	+3
2.1.19(Y28)	Knows food constituents	41	W	38	W	-3
2.1.22(Y39)	Knows motion of pendulum	46	S	43	S	-3
2.1.23(Z03)	Knows cause of day and night	43	M	45	W	+2
2.1.31(Z35)	Knows pitch relates to size	63	S	65	VS	+2
2.1.32(Z36)	Knows theory of natural selection	41	M	43	S	+2
2.1.33(Z40)	Knows earth exerts gravitational force	50	M	58	S	+8
2.3.04(X39)	Knows procedures if acid splashed	77	VS	78	M	+1
2.3.07(Y14)	Knows to wash after procedures	72	S	72	S	0
2.3.12(Z34)	Knows procedures in heating test tube	27	W	34	W	+7
Mean Percent Correct		55.2		56.7		+1.5
Standard Error of the Mean		0.1		0.2		

The considerations which relate to these tables reinforce the statements in Section 4.5 that those areas in which achievement was acceptable in 1978 are still acceptable, and that areas identified in 1982 as weaknesses were not assessed as thoroughly in 1978.

A further comparison bears this out. Table 4.16 compares the distribution of ratings of pupil performance on items by the Interpretation Panels of the two Assessments. Performances of "Very Satisfactory" or "Strong" were given to a smaller percentage of the items in 1982 than in 1978 even though the achievement levels were almost the same.

Table 4.16: Distribution of Ratings of Student Performance in 1978 and 1982

Rating Category	Percent of Items 1978 (based on 92 items)	 1982 (based on 120 items)
Strong	8	4
Very Satisfactory	29	18
Satisfactory	32	33
Marginal	17	31
Weak	14	14

4.7 Grade 4-Grade 8 Comparisons

Eight items, called cross-grade items, appeared in identical form on both the Grade 4 and Grade 8 Assessments. Two other items were the same except that the Grade 8 item had an additional foil. An eleventh item was very similar in intent but differed in wording, and had an additional foil at Grade 8. Five of these items dealt with safety procedures. Table 4.17 presents comparative data for these items. In all cases except one (X01 at Grade 8 or Y21 at Grade 4), which is discussed in Sections 3.3.3 and 4.3.3, the Grade 8 performance is higher than the Grade 4 performance, and in many cases it is substantially higher. For the safety items, it is evident that both Interpretation Panels had high standards of acceptable performance, and both expressed concerns. It is encouraging to see substantial growth on most of these items from Grade 4 to Grade 8.

Table 4.17: Results on Cross-grade Items Grade 4 and Grade 8

Grade 4 Number	Grade 8 Number	Description	Grade 4		Grade 8	
			Percent Correct	Panel Rating	Percent Correct	Panel Rating
1.2.08(Y18)	1.1.02(X24)	Deletes by stated attribute	80	VS	86	VS
1.2.15(Z17)	1.1.09(Z20)	Recognizes and applies class rule	75	VS	87	ST
1.2.17(Z26)	1.1.05(Y29)	Recognizes and applies class rule	41	M	65	VS
1.3.16(Z31)	1.2.09(Z22)	Selects best diagram of a description	58	M	87	ST
2.1.01(X02)	2.1.18(Y26)	Knows cause of year	63	M	78	VS
2.1.10(Y14)	2.1.11(X37)	Knows functions of plant parts*	51	M	72	VS
2.3.01(X14)	2.3.10(Z13)	Knows hazard of lye and drano**	37	W	57	M
2.3.02(X20)	2.3.05(Y07)	Knows procedures in case of fire	44	W	83	M
2.3.04(Y01)	2.3.03(X28)	Knows how to test hot metal*	37	W	51	M
2.3.05(Y21)	2.3.01(X03)	Knows procedures for broken glass	80	S	77	S
2.3.09(Z25)	2.3.11(Z27)	Knows animal hazards	70	M	79	S
Mean Percent Correct			57.8		74.7	

* Grade 8 item had one more foil than Grade 4 item.
** Grade 8 item was worded differently from Grade 4 item.

4.8 Achievement of Specific Pupil Sub-Groups

A random sample of just over 10% of the Grade 8 pupils who wrote the instrument was selected for further analysis. The analysis involved procedures to analyze the data by gender, by language first spoken, by language now spoken at home, etc. These data were obtained from pupil responses to the background information questions. A chi-square analysis of each item by gender was also carried out.

4.8.1 Sex-Related Differences in Achievement

Table 4.18 presents the results of the analysis by gender for each domain and objective in Grade 8. In addition, the 33 items of Objective 2.1--Knowledge of Biological, Physical and Earth/Space Science Concepts, were analyzed by the content area of the items. In two of the three domains, there are statistically significant differences between the performances of boys and girls. In Domain 1--Science Processes, there is no difference between the overall performance by gender, but boys' performance on the objective Communicate exceeded girls' by 2.9%, and girls' performance on the objective Identify and Control Variables exceeded boys' by 2.6%. Both of these differences would occur by chance less than five percent of the time. In the knowledge domain, the performance of boys was superior to that of girls by four percentage points. This difference was chiefly the result of lower achievement, by about 8.5%, in items measuring knowledge of physical science and earth/space science concepts. In Higher Level Thinking, boys' scores exceeded girls' scores by 9.7% in apply concepts and by 4.8% in Use Rational and Critical Thinking.

A short discussion of the trends shown by the data at all grade levels is found in Section 3.7.1. Over the grades, boys' performance on the Science Processes improved relative to girls' performance. In terms of knowledge concepts, boys' performance exceeded girls' at all levels, but this was not true in other objectives of the knowledge domain. When success on a process, application or critical thinking item is dependent on a knowledge of science concepts, then the higher achievement of boys relative to girls increases. This phemomenon is particularly illustrated in Objective 3.1, apply concepts, at this grade level, and continues in Domain 3, particularly in solve abstract problems at the Grade 12 level.

Chi-square analysis showed significant sex-related differences on 63 items, or just over 50% of the items. Eight of these were significant only because of differential choices in incorrect distractors. In 75% of the items where significant differences existed in correct responses, a higher percentage of boys than of girls selected the correct response. All such items were examined for clues as to possible reasons for the sex-related differences. No consistent patterns were found. Sometimes, girls outperformed boys on items with longer reading selections and on questions involving a "health" component. A number of items might have favoured boys more than girls because of a different background of out-of-school experiences. For example, there were large differences in favour of boys on all questions involving electricity and magnetism. On the other hand, it is difficult to see any reason why the boys' response was 18.5% above that of the girls' on the water mixing item (X10) or 5.9% better on the item on lungs (Y01).

Table 4.18: Sex-Related Differences in Grade 8 Achievement

Domain/Objective	Mean Percent		Difference
	Male	Female	Male - Female
Domain 1 - Science Processes	59.0	59.2	-0.2
Objectives			
1.1 Classify	66.8	68.0	-1.2
1.2 Communicate	68.5	65.6	+2.9*
1.3 Interpret Data	56.7	56.3	+0.4
1.4 Identify and Control Variables	44.1	46.7	-2.6*
Domain 2 - Knowledge	57.4	53.4	+4.0
Objectives			
2.1 Science Concepts	56.5	50.3	+6.2**
2.2 Applications/Nature of Science	51.4	50.0	+1.4
2.3 Safety	65.8	65.1	+0.7
Domain 3 - Higher Level Thinking	50.7	45.9	+4.8**
Objectives			
3.1 Apply Concepts	54.0	45.3	+8.7**
3.2 Rational and Critical Thinking	50.7	45.9	+4.8**

Males, N = 1560; Females, N = 1481

* $p < .05$
** $p < .01$

4.8.2 Differences related to Language Backgrounds

Analysis of variance was also used to compare the performance of pupils who usually spoke English at home with pupils who usually spoke another language at home. The analysis for domains is shown in Table 4.19. Pupils whose home language was not English had domain scores which averaged 4.9% lower than those who spoke English at home. The analysis of variance for objectives shows the differences in mean scores to be statistically significant for all objectives except Identify and Control Variables and Applications of Science (Technology)/and the Nature of Science.

Table 4.19: Language Spoken at Home and Achievement--Grade 8

Domain	English	Non-English	Diffeerence E - NE
Domain 1: Science Processes	59.3	55.1	4.2*
Domain 2: Knowledge--recall and understand	55.8	49.6	6.2**
Domain 3: Higher Level Thinking	48.6	44.3	4.3**
English, N = 2874 Non-English, N = 167			

* $p < .05$
** $p < .01$

A similar analysis was done comparing pupils whose first language was English with those who first spoke another language. The mean difference for domain scores was 3.1. The differences in the Science Processes domain, and all of its objectives and in Applications of Science (Technology)/Nature of Science were not statistically significant. All other differences were significant.

Cross-tabulation data showed that 64% of the pupils whose first language was not English now usually speak English at home.

The picture which emerges from these analyses and those at Grade 4 is that children who do not learn English as a first language are placed at a disadvantage in the learning of science. This disadvantage may be lessened as the family switches to English as the language at home, and the disadvantage is lessened as the child progresses in school. The objective and domain means for those whose home language is not English are consistently lower than the means for those whose first language was English. The picture is somewhat confounded by the fact that there is a continuous flow of immigrant children into the school system. Forty percent of the pupils who did not commonly speak English at home have immigrated from foreign countries since the pupil was in Grade 4. This is one percent of the Grade 8 population. The disadvantage due to language is less in the Science Processes domain, particularly where quantitative, graphical and pictorial materials are used, and, therefore, one would assume this would also be true where hands-on activities are used.

4.9 Pupil Attitudes/Interests/Opinions

In an attempt to judge the attitudes and opinions of Grade 8 pupils toward various non-cognitive aspects of science, the following short scales were placed at the beginning of the achievement booklets as shown below.

Form X	Form Y	Form Z
● Interest in Science Topics	● School Science	● Specific Issues
● Scientists	● Science and Society	● Careers in Science

Brief descriptions of the attitude/interest/opinion instruments are found in Section 2.3 and the actual questionnaires along with the provincial results are reprinted in Appendix F. The remainder of this chapter begins with a discussion of the results of the School Science scale and then interprets the results of the other instruments in an order that parallels the discussion of the Grades 10/12 results contained in Chapter 5. Differences between the Grade 8 and Grades 10/12 results are reserved for Chapter 5.

4.9.1 School Science Scale

One way to interpret attitude results is in terms of the proportion of pupils whose scores are at or above the mid point of the scale (i.e. the proportion of pupils selecting positive responses). In the School Science scale, the percentile equivalent of score 30, which divides the scale into the negative and positive sections, is 24, meaning that 24% of the pupils scored below 30 and therefore 76% scored at or above 30 or on the positive side of the scale. One can conclude that, at the Grade 8 level, pupils' attitudes are very positive toward school science.

4.9.1.1 Sex-Related Differences

Although boys scored higher than girls on the School Science scale, analysis showed that the mean scores were not significantly different. A chi-square analysis was performed on each item to investigate the relationship between sex and response category choices. The chi-square values for four items (1, 4, 5, 6) were statistically significant. Two items of interest are reprinted below with the responses expressed in terms of boys' and girls' percentages.

1. I LIKE TO STUDY SCIENCE IN SCHOOL

	Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree	Total
Boy	5	13	15	57	10	100
Girl	2	18	21	52	7	100
Total	4	15	18	54	9	100

Boy N = 522 df = 4 Chi-square = 20.79 p = .01
Girl N = 481

Item 1's point bi-serial correlation of .685 with the total score was the highest on the scale. As such, it can be considered as the one item that is most representative of the scale. Boys "Agree" or "Strongly Agree" with the statement to a greater extent than girls while the latter "Disagree" or "Can't Decide" to a greater extent than boys. This type of difference tends to give boys a higher scale score than girls.

5. I WOULD LIKE TO STUDY MORE SCIENCE.

	Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree	Total
Boy	8	24	26	33	9	100
Girl	6	33	28	26	7	100
Total	7	28	27	30	8	100

Boy N = 521 df = 4 Chi square = 15.43 p = .004
Girl N = 482

Item 5 had the lowest mean score on the scale (2.96) but it also had a very high point bi-serial correlation (.670). These factors suggest the responses should be studied. Note that, of the total, 62% are either undecided or do not want to study more science. It is very unfortunate to have such a large proportion of pupils respond in this way at the grade eight level. The proportions of boys and girls choosing each category are very similar except for the differences in the "Agree" and "Disagree" columns. It is this pattern of response that moves the boys higher up the scale than the girls.

4.9.1.2 Attitudes Toward School Science in Relationship to Various Reporting Categories

A variety of univariate analysis of variance tests were conducted to determine possible differences in attitude toward school science. Among the independent variables were the following found in the Background Information section of Form Y: Gender, First Language Learned, Home Language Now, Science Courses Completed, and Method of Scheduling Science Courses. No statistically significant differences ($p< .05$) were found. However, statistically significant correlations ($p< .01$) were found between attitude toward school science and the following domains: Domain 1, $r = .22$; Domain 2, $r = .27$; Domain 3, $r = .17$. The size of correlations increased as the number of items on the domain sub-tests increased. Although the correlations are small from a practical point of view, they are high compared with others found in the professional literature.

4.9.2 Attitudes Towards Scientists

The percentile equivalent of score 30, which divides the scale into the negative and positive sections, is 11, meaning that 11 percent of the pupils scored below 30 and, therefore, 89% scored at or above 30 or on the positive side of the scale. One can conclude therefore that, at the grade 8 level, pupils' attitudes toward scientists are very positive.

4.9.2.1 Boy-Girl and Other Differences

An analysis of variance test did not reveal significant differences in the mean scores of boys and girls on the Scientists scale. However, the two following items did show interesting sex-related differences.

5. SCIENTISTS ARE PROBABLY RIGHT WHEN THEY SAY THAT THE PLANETS DO NOT DETERMINE SUCCESS AND FAILURE IN OUR DAILY LIVES

	Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree	Total
Boy	5	15	27	38	15	100
Girl	3	17	40	34	6	100
Total	4	16	34	36	10	100

Boy N = 514 df = 4, Chi square = 33.35, $p < .01$.
Girl N = 505

Girls tended to be undecided about the statement while a larger percentage of boys chose the "Strongly Agree" option. Forty-seven percent of the boys and 60% of the girls did not indicate agreement with the statement. It should be of concern to all teachers that many pupils appear to take astrology seriously.

Of course, it can be argued that the statement is not really representative of the attitudinal object i.e. Scientist. The Contract Team can agree and is supported by the relatively low item-total biserial correlation of .17.

4.9.3 Attitudes Toward Science and Society

The percentile equivalent of score 36, which divides the scale into negative and positive regions is 17, meaning that 17% of the pupils scored below 36 and, therefore, 83% scored at or above 36 or on the positive side of the scale. One can conclude that, at the grade 8 level, pupils' attitudes toward the place of science in society are very positive.

4.9.3.1 Sex-Related and Other Differences

An analysis of variance test did not reveal any differences in the mean scores of boys and girls on the Science and Society scale. However, the following two items did show interesting sex-related differences.

6. SCIENTIFIC INVENTIONS AND DISCOVERIES HAVE DONE MORE GOOD THAN HARM FOR MANKIND

	Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree	Total
Boy	5	12	19	41	23	100
Girl	3	7	19	50	21	100
Total	4	10	19	45	22	100

Boy N = 517 df = 4, Chi square = 15.35 $p < .01$
Girl N = 479

A comparison of the data related to Item 6 above with that related to Item 6, (see below) a similar type of item from the Scientists scale suggests that scientists cannot be held totally responsible for any harm that has been done to mankind through the use of scientific inventions and discoveries.

6. SCIENTISTS HAVE DONE MORE HARM THAN GOOD IN THIS WORLD

	Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree	Total
Boy	37	35	14	9	5	100
Girl	37	44	13	4	2	100
Total	37	40	13	6	4	100

Boy N = 516 df = 4, Chi-square = 19.52, $p < .06$.
Girl N = 506

4.9.4 Attitudes Toward Careers in Science

Thirteen items were included in the Careers in Science scale. However, only ten items were used in developing the scale statistics. Three items (2, 8, and 13), each referring to either a boy or a girl, were included to measure boy-girl differences related to scientific careers. The Hoyt internal-consistency reliability for the scale (.91) was the highest of all of the Grade 8 affective instruments. However, as shown in Table 2.9, the mean score was the lowest.

The percentile equivalent of score 30, which divides the scale into negative and positive sections, is 48, meaning that 48% of the pupils scored below 30 and, therefore, 52% scored at or above 30 or on the positive side of the scale. One can conclude that pupils in Grade 8 have a relatively low interest in pursuing scientific careers.

4.9.4.1 Sex-Related and Other Differences

An analysis of variance revealed no significant differences in the relatively low mean scores of boys and girls on the Careers in Science scale.

Item 11 is illustrative of results indicating low student interest in a scientific career. One might conclude that the 22% in the "Can't Decide" column is due to the level of vocational maturity of Grade 8 pupils but, as will be shown in the following chapter, approximately the same proportions of pupils chose the option at both the Grade 10 and Grade 12 levels.

11. I WOULD BE SATISFIED TO SPEND MY LIFE AS A SCIENTIST

	Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree	Total
Total Group	14	44	22	16	4	100

N = 1027

As was mentioned earlier, three items were included in the questionnaire in order to measure sex-related differences in relation to boys' and girls' opinions on the appropriateness of the opposite sex engaging in a scientific career. Because the data for Grade 8 are very consistent with those of Grades 10 and Grade 12, the discussion of the results is reserved for Section 5.9.4 in Chapter 5.

4.9.5 Interest in Science Topics

Because the British Columbia science curriculum guide emphasizes developing pupils' interests in science, statements were constructed to survey Grade 8 pupils interests. Three topics in each of the four science content areas were interspersed throughout the questionnaire. The British Columbia results are contained in Appendix F. Table 4.19, based on sample data, shows male-female responses to the various topics.

The results from the very short list of science topics show that there are strong sex-related differences in specific topics and that interests vary greatly in strength across topics. Teachers are encouraged to survey their pupils' interests in science topics and then use the results for planning potentially motivating experiences.

Table 4.19: Grade 8, Interest in Science Topics, Sex-Related Differences

		Response Categories		
Science/Topic	Gender	Not Interested	Somewhat Interested	Very Interested
Biology				
1. Different diseases people have	M	32	58	10
	F	11	65	24
5. How to dissect animals	M	27	35	38
	F	36	34	30
9. Control of plant-destroying insects	M	59	35	6
	F	47	43	10
Physical Sciences				
2. Electric power production	M	25	54	21
	F	59	36	5
6. How sound comes from tapes	M	19	47	34
	F	24	48	28
10. Chemicals in food	M	39	43	18
	F	17	55	28
Earth/Space				
3. Solar energy	M	14	53	33
	F	29	60	11
7. Why volcanoes erupt	M	25	55	20
	F	18	60	22
11. Planets	M	18	46	36
	F	24	49	27
Technology				
4. How paper, cans and bottles are recycled	M	64	31	5
	F	51	42	7
8. How rockets work	M	16	41	43
	F	56	35	9
12. How to work computers	M	8	21	71
	F	14	38	48

Male N = 516 Female N = 508

CHAPTER 5

GRADE 12 RESULTS

Hugh Taylor and Robert M. Hunt

This chapter reports and interprets the achievement and affective results of pupils in Grades 10 and 12. Discussions of the development and the organization of the measuring instruments are contained in Chapter 2 and all the assessment survey items are reproduced in Appendix G.

Of particular interest and importance are the ratings of the Provincial Interpretation Panels for the Grade 12 results in the various objectives and domains that were considered priorities in the updated Junior Secondary Science Curriculum Guide (1982). These ratings provide current baseline data and supply important judgements as to the status of science achievement of pupils who were enrolled in their last year of public education. Panel members used the following scale in their ratings:

Strong........................	ST
Very Satisfactory.............	VS
Satisfactory..................	S
Marginal......................	M
Weak..........................	W

Ratings and interpretions will be presented in Sections 5.2-5.4. Section 5.5 includes other interpretations of the achievement data such as sex-related differences, Grade 10 and 12 differences, and language differences. Section 5.6 concludes the chapter with a presentation of the affective results which were obtained through the use of six sets of items.

5.1 Description of the Pupils Who Wrote the Assessment Instruments

The numbers of pupils at the Grade 10 and 12 levels that responded to the two forms of the assessment instruments are shown in Table 5.1.

The Grade 12 total represents approximately 80% of the Grade 12 enrollment of the schools that participated in the assessment calculated on the basis of their enrollment as of September 1981. The Grade 10 total is a stratified random sample of the population. The Grade 12 total is approximately 61% of the provincial pupil population. Appendix G contains data that describe the two groups in further detail. The following sections (5.2-5.4) interpret objectives and domain results based on the data obtained from the 22 110 Grade 12 pupils listed in Table 5.1.

Table 5.1: Numbers of Grade 10 and 12 Students Who Participated in the Science Assessment by Achievement Survey Forms

Grade	Booklet X	Booklet Y	Total
10	986	1004	1990
12	11 063	11 047	22 110

5.2 Domain 1--Science Processes

5.2.1 Interpret Data

Ten items were chosen to assess the pupils' skills at interpreting information from graphs and tables. Ideally, students learn such skills from experimental situations in which they observe or measure changes and then generate interpretations or conclusions. Since the assessment format precluded the possibility of such activities, data had to be presented in accepted standard forms used in science--graphs or tables.

Table 5.2 shows the provincial results for the items of this objective. The Interpretation Panel rated the results as "Marginal". Although it can be assumed that many pupils spend many hours gathering data from experiments, it appears that they still need to have more practice in the actual interpretation of their observations, and in stating results in graphic form. An increase in teaching interpretation of data through graph and table analysis also appears warranted.

Items X04 and X05 illustrate some of the difficulties encountered by the pupils. Most data interpretation requires complex thinking, so that success should vary inversely with the number of variables used in a question. A majority of pupils were therefore able to find the correct solution to Item X04, where "mouth" intersected with "pH of 6.2", but the same cannot be said for Item X05. In the latter case, the "Weak" rating perhaps can be explained by the introduction of two other variables--the order in which parts of the digestive tract occur and location of the activities of maltase and lactase. Another factor which may have made the item difficult was the use of unfamiliar words or symbols; 35% of the pupils responded "I don't know", suggesting that this question was very difficult indeed.

Table 5.2: Provincial Results for the Grade 12 Objective Interpret Data

Item No.	Description	Percent Correct	Panel Rating
1.1.1 (X04)	Identify conclusion from the data	55	S
1.1.2 (X05)	Identify conclusion from the data	22	W
1.1.3 (X14)	Identify conclusion from the data	66	M
1.1.4 (X15)	Identify trends from tables or graphs of data	77	VS
1.1.5 (Y05)	Given a hypothesis and a set of data, decide if data confirm or deny the hypothesis	40	M
1.1.6 (Y06)	Use average values when appropriate	31	M
1.1.7 (Y08)	Recognize the best conclusion that may be drawn from the data	56	M
1.1.8 (Y11)	Evaluate evidence for a reasonable conclusion	80	VS
1.1.9 (Y22)	Identify conclusion from the data	44	M
1.1.10 (Y23)	Identifiy conclusion from the data	59	S
	Mean Percent Correct Overall Rating	53.0 Marginal	

5.2.2 Identify and Control Variables

Grade 12 pupils should be knowledgeable about the scientific method and its importance in scientific experimentation. Expectations were therefore high that the process Identify and Control Variables and its relationship to experimental design would be familiar and well handled on the achievement forms.

Table 5.3 reports the results and Panel ratings for the 12 items of the objective. Although the Panel gave this objective an overall rating of "Satisfactory", note that five of the 12 items were rated as "Marginal" or "Weak", while only one item was rated "Strong". The Contract Team joins the Interpretation Panel in recommending that teachers give their students more practice in experimental design as well as in identifying and controlling variables.

Table 5.3: Provincial Results for the Grade 12 Objective
Identify and Control Variables

Item No.	Description	Percent Correct	Panel Rating
1.2.1 (X07)	Select an appropriate experimental design	44	M
1.2.2 (X10)	Select an appropriate experimental design	65	S
1.2.3 (X16)	Select variables to be controlled in a simple experiment	56	S
1.2.4 (X19)	Identify the least important variable to control in an experiment	69	S
1.2.5 (X30)	Identify the impact of changing one variable	67	S
1.2.6 (X33)	Identify the variable in an experimental situation	48	M
1.2.7 (X35)	Identify a variable which is not related to the problem	47	S
1.2.8 (Y02)	Identify the most important variable to control in an experiment	85	ST
1.2.9 (Y09)	Identify the variable which must be controlled	50	M
1.2.10 (Y14)	Select valid criticisms of an experimental design	29	W
1.2.11 (Y21)	Identify the most important variables to control in an experiment	58	S
1.2.12 (Y28)	Select valid criticisms of an experimental design	63	M
	Mean Percent Correct	56.8	
	Overall Rating	Satisfactory	

Examination of Item X33, judged as "Marginal", indicates that many pupils may not understand the meaning of holding a variable constant. The negative form of the stem may also have caused difficulty. On the other hand, the responses to Item Y09, rated "Marginal", may have been caused by a lack of knowledge of density rather than by a weakness in understanding the experimental process.

X33 In a teaching experiment fifty students were divided at random into two equal groups. One group was taught using igneous rocks; the other sedimentary rocks. Both classes were held in the afternoon. In the experiment, the factor which was NOT held constant was

the size of the groups.	6
the topic of rocks.	20
the type of rocks.	50*
the time of day of the classes.	14
I don't know.	9

Y09 Salt may be added to a solution until it will float an egg. This statement is based on the assumption that all eggs have

equal weight.	12
equal volume.	11
equal density.	50*
about the same shape.	11
I don't know.	16

* correct response

Y02 was the only item to be given a "Strong" rating. Even though pupils' knowledge of drugs may have produced the high percentage, it seems far more likely that they really could recognize the most important variable to control in this and similar experiments.

5.3 Domain 2--Knowledge--recall and understand

5.3.1 Major Concepts, Basic Principles, Laws and Supporting Facts of Science

Sixteen items taken from biology, chemistry, physics, and earth/space science were used to assess achievement of knowledge of science facts, concepts, principles, and vocabulary. All 16 items were change items which had been used in the 1978 Science Assessment. A comparison of the 1982 with the 1978 achievement levels on the items is reported in Section 5.6.

Table 5.4 summarizes the results and the Interpretation Panel's ratings of items. Results for this objective are disappointing and are reflected in the "Marginal" overall rating. Of the 16 items, six were rated "Marginal", and only one was deemed to be "Very Satisfactory". The Interpretation Panel reported that pupils had displayed an "inadequacy of knowledge" of this objective.

Table 5.4: Provincial Results for the Grade 12 Objective Major Concepts, Basic Principles, Laws and Supporting Facts of Science

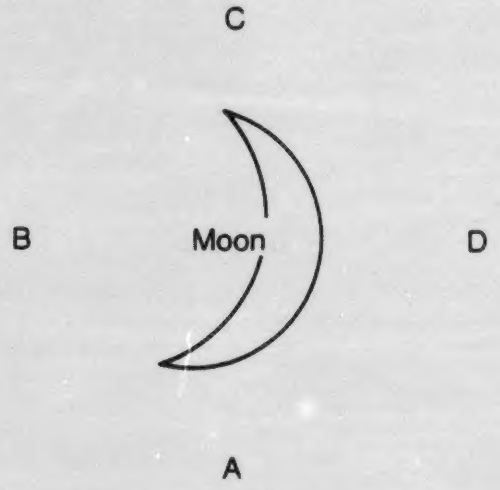
Item No.		Description	Percent Correct	Panel Rating
2.1.1	(X02)	Meaning of "ion"	47	VS
2.1.2	(X09)	Why is fossil fish found on mountain	43	M
2.1.3	(X17)	Molecules are further apart in steam than in ice	68	S
2.1.4	(X18)	Embryo develops in uterus	54	M
2.1.5	(X22)	Food providing most protein	64	M
2.1.6	(X23)	Erosion and valley development	33	S
2.1.7	(X26)	Natural selection	55	S
2.1.8	(X27)	Electrons are involved in chemical bonds	51	S
2.1.9	(X31)	Concept of inertia	44	S
2.1.10	(Y01)	Meaning of "compound"	46	S
2.1.11	(Y04)	Function of perspiration	65	S
2.1.12	(Y07)	White relects light	76	S
2.1.13	(Y18)	Green plants produce food	63	M
2.1.14	(Y20)	Meaning of "efficiency" of machines	50	S
2.1.15	(Y27)	Moon phases	47	M
2.1.16	(Y33)	Density of water	32	M
		Mean Percent Correct	52.4	
		Overall Rating	Marginal	

The seriousness of these results is amplified by the frequency of the "I don't know" responses. Responses to Item X02, rated "Very Satisfactory", showed that 27% of the pupils chose the "I don't know" option. Also, for Item Y01, rated "Satisfactory", 30% of the pupils chose "I don't know". Similar responses can be found to other items. Such general lack of knowledge must be a major concern to educators.

Two items (Y27, Y33) illustrate relatively poor performance. Item Y27 shows a lack of understanding of how bodies in space are illuminated and also a difficulty in orienting objects spatially. The latter weakness is demonstrated again in Item Y03, found in the Higher Level Thinking domain. The response pattern of Item Y33 may be because many pupils associate the Equator with warm air; hence distractor C seems very sensible.

Some mention should also be made about the "Marginal" ratings for Items X18 and Y18 (see Appendix G). It seems alarming that only 54% of Grade 12 pupils know that human embryos normally develop in the uterus. A cross-tabulation by sex showed that 44% of the boys and 64% of the girls knew the correct answer. Also, considering the importance of green plants to animals (Item Y18), a 63% correct response seems too low for secondary students.

Y27 Look at the diagram below.



The sun would be located at position

A.	9
B.	20
C.	6
D.	48*
I don't know	17

* correct response

Y33 Think of diving into the ocean near the Equator. As you go deeper, the water gets colder because

the saltiest water is always coldest and sinks to the bottom.	4
warm water is lighter than cold water and stays on top.	34*
the deeper water is not in contact with the air.	51
volcanic activity warms only the upper layers of the water.	2
I don't know.	9

* correct response

5.3.2 Applications of Science (Technology)/Nature of Science

Included in this objective are two sub-objectives which both relate to the nature of science and its interaction with society, a theme which has become of critical importance in the world today. Six items were used to measure this objective. Results and the Interpretation Panel's rating are summarized in Table 5.5.

Table 5.5: Provincial Results for the Grade 12 Objective Applications of Science (Technology)/Nature of Science

Item No.		Description	Percent Correct	Panel Rating
2.2.1	(X01)	Incompleteness of scientific knowledge	63	M
2.2.2	(X13)	Knowledge of "understanding science" as opposed to being informed about science	67	VS
2.2.3	(X20)	Relationship between facts and theory	63	S
2.2.4	(X21)	Relationship between science and technology	33	M
2.2.5	(Y29)	Knowledge of the nature of an hypothesis	57	S
2.2.6	(Y34)	Know that scientific knowledge cannot be morally judged but that the applications of the knowledge can be judged	72	S
		Mean Percent Correct Overall Rating	59.3 Satisfactory	

Overall rating for the objective was "Satisfactory". However, the Panel felt that there should be more emphasis on the applications of science in the Grades 8-10 programs. Indeed, analysis of the responses to this objective reveals that pupils seem to have a satisfactory grasp of the nature of science, but they have difficulty relating science and technology.

5.3.3 Safety Procedures

Knowledge of safety must be an objective given the highest priority by science teachers. The Interpretation Panel expected high performance in this area of achievement of all students completing Grade 12. In order to examine this important area, eight items were selected of which four were from the 1978 Science Assessment forms. Item comparisons across the two years are reported in Section 5.6. Table 5.6 summarizes the provincial results and the panel ratings.

Table 5.6: Provincial Results for the Grade 12 Objective Safety Procedures

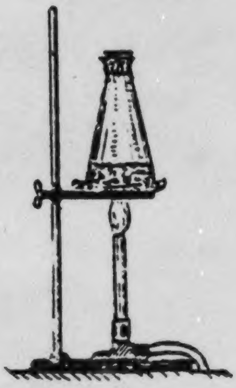
Item No.		Description	Percent Correct	Panel Rating
2.3.1	(X03)	Know action to take in certain hazardous situations	57	W
2.3.2	(X12)	Identification of flammable volatile liquids	71	S
2.3.3	(X29)	Purpose of fuse or circuit breaker	55	M
2.3.4	(X32)	Know dangers of tasting chemicals	62	M
2.3.5	(Y16)	Heating liquid in test tube	67	M
2.3.6	(Y17)	Diluting acids	25	W
2.3.7	(Y24)	Procedure for smelling odours	64	S
2.3.8	(Y35)	Know how to light a bunsen burner	44	M
		Mean Percent Correct	55.6	
		Overall Rating	Marginal	

The Interpretation Panel assigned a "Marginal" rating to the Safety Procedures objective. In the Contract Team's opinion, this rating seems high because, although out of eight items, two were rated as "Weak", four as "Marginal" and two as "Satisfactory", the Mean Percent Correct of 55.6 seems far too low. Pupils should not be "half-safe".

Two items which, in the Contract Team's opinion, exemplify weakness are X03 and X29. These items are chosen not only because of their importance in laboratories and classrooms, but also because of their application as safety features in the home or the world of work.

The Interpretation Panel expressed concern over performance in the area of safety. Teachers are strongly urged to ensure that safety instruction be adjusted and increased to remedy the demonstrated weakness.

X03 A student is boiling water in a stoppered glass jar or flask, as shown. What precaution would you take if you saw this?



Immediately turn off the gas to the burner	55*
Make sure the stopper is in tightly so the steam cannot escape.	4
Make sure the gas line does not become disconnected. .	5
Keep the burner turned down to low heat.	31
I don't know	5

* correct response

X29 The purpose of a fuse or circuit breaker is to

turn light on and off.	4
protect circuits from carrying too much electricity.	54*
protect people from getting electric shocks.	4
save electricity from being wasted	3
regulate the number of volts in the circuit.	28
I don't know	6

* correct response

5.4 Domain 3--Higher Level Thinking

5.4.1 Evaluate Evidence for Conclusions

Drawing conclusions is one of the crucial activities of science, and its proper performance necessitates varying degrees of rational and critical thinking. The development of such abilities in students depends upon cognitive development and exposure to experiences which provide opportunities for practising this type of thinking. In order to assess the level of higher thinking reached by Grade 12 pupils, six items were selected.

Table 5.7 presents the provincial results and Panel ratings for this objective. The Interpretation Panel rated pupil performance as "Marginal".

Analyses of the results are revealing. The one item rated "Strong" was deemed to be the easiest question in this objective. One item rated "Satisfactory" (Y26) was obviously a difficult question as pupils not only had to apply knowledge of the different states of matter to a "before and after" format, but also had to ascertain the correct reason for the observed change. The 24% response of "I don't know" indicates the difficulty.

The two items rated "Marginal" and one deemed to be "Weak" may have implications for teaching practices. Item X06 was designed to examine the pupils' ability to base conclusions on evidence. Pupils may not be taught rigorously enough to accomplish this objective. Item Y15 examined the pupils' abilities to recognize the limits to conclusions which may be drawn from data. From these results, one wonders whether or not these abilities are being developed sufficiently.

Table 5.7: Provincial Results for the Grade 12 Objective Evaluate Evidence for Conclusions

Item No.		Description	Percent Correct	Panel Rating
3.1.1	(X06)	Recognize the observation which is needed evidence for a conclusion	58	M
3.1.2	(X08)	Recognize the conclusion which is best supported by observations	86	ST
3.1.3	(Y03)	Evaluate evidence for a reasonable conclusion	48	W
3.1.4	(Y15)	Recognize the evidence as insufficient to warrant such a conclusion	50	M
3.1.5	(Y26)	Recognize the conclusion which is best supported by the observations	51	S
3.1.6	(Y31)	Recognize the appropriate conclusion that may be drawn from the observations	57	S
		Mean Percent Correct	58.3	
		Overall Rating	Marginal	

The one "Weak" item (Y03) is rather intriguing. Apparently orienting oneself as to direction is indeed a higher level skill. Certainly, the description quoted from The Rhyme of the Ancient Mariner does not contain difficult language, so the problem seems to be with the thinking process.

The Interpretation Panel urged teachers to work on the area of evaluating evidence. A change in classroom practices may be indicated, so that the emphasis now perhaps being placed on lower levels of Bloom's Taxonomy be adjusted to higher ones such as "Analysis" and "Evaluation".

Y03 A poem entitled "The Ancient Mariner" contains the lines:

"The sun now rose upon the right
Out of the sea came he,
Still hid in mist, and on the left
Went down into the sea."

In which direction was the Ancient Mariner sailing?

North	45*
South	16
East	13
West	19
I don't know	7

* correct response

5.4.2 Solve Abstract Problems

The solution to abstract problems is another important activity of science, often requiring very complex forms of thinking.

Educators hope that pupils graduating from Grade 12 are equipped with enough of these strategies to enable them to cope adequately with the many abstract problems encountered in a complicated world. Since formal thinking is involved in performing this type of activity, it was expected that pupils would have considerable difficulty with the 12 items used to measure this objective. This was indeed found to be true.

All items assessing this objective were selected from the 1978 Science Assessment forms by the Technical Sub-Committee. The interpretation of the 1982 results compared with those of 1978 is reserved for Section 5.8. In general, these items fulfilled the content validity of the objective and the difficulty range required for items measuring change. The Interpretation Panel suggested that some of the change items were testing recall and not the ability to reason.

Table 5.8 summarizes the provincial results and the Panel ratings. The Interpretation Panel assigned an overall rating of "Marginal" to this objective. Only six of the items were judged to be "Satisfactory", while four were rated "Marginal", and two "Weak". The Mean Percent Correct of 44.7 was the lowest of any of the objectives, as one might expect.

Table 5.8: Provincial Results for the Grade 12 Objective
Solve Abstract Problems

Item No.	Description	Percent Correct	Panel Rating
3.2.1 (X11)	Advantage of capillary system in blood circulation	50	S
3.2.2 (X24)	Recognition of producers in food web	48	M
3.2.3 (X25)	Electrical circuits	58	S
3.2.4 (X28)	Kinetic molecular explanation of diffusion	45	S
3.2.5 (X34)	Distances in the universe	31	W
3.2.6 (Y10)	Inheritance of blood type	51	S
3.2.7 (Y12)	Increasing carbon dioxide in air from burning fossil fuels	37	W
3.2.8 (Y13)	Safety in thunderstorms	42	M
3.2.9 (Y19)	Effects of inclination of Earth's axis	40	S
3.2.10 (Y25)	Fixed proportions in chemical reaction	33	M
3.2.11 (Y30)	Disposal of nuclear wastes	64	S
3.2.12 (Y32)	Formation of igneous rocks	36	M
	Mean Percent Correct	44.7	
	Overall Rating	Marginal	

Y12 is an example of an item classified as "Weak" by the panel. Here is clearly a case of the distractors being true or partly true; hence many pupils were led away from the correct answer or simply replied "I don't know".

An example of an extremely difficult item which was rated "Satisfactory" is Item Y19. Apparently, the mental strategies required to assess the effects of the Earth's axis angle being changed were too taxing or were missing for a majority of the pupils--42% responded "I don't know". The fact that the Interpretation Panel assigned a "Satisfactory" rating to an item with a 40% correct response highlights the difficulty level.

Y12 Atmospheric carbon dioxide is believed to be increasing due to

decreased carbon dioxide fixation by green plants. . .	15
increased release from volcanoes.	2
increased burning of fossil fuels.	38*
cutting down of too many trees.	21
I don't know.	24

* correct response

The Contract Team again strongly agrees with the Interpretation Panel in expressing disappointment with student performance on this objective. Teachers are urged to devise methods and practices which will enhance pupils' experiences with higher level thinking activities.

5.5 Summary of the Grade 12 Interpretation Panel Ratings

Table 5.9 presents the number of items for each objective and domain rated by the Interpretation Panel on the basis of five evaluative categories. Also presented are the mean percent correct for the objectives and domains along with the overall evaluative ratings.

It is discouraging to note that the Interpretation Panel judged only six of the 70 items above the "Satisfactory" category and that all three domains were rated below "Satisfactory". Science teachers and others will have to consider very seriously the implications of these judgements.

5.6 Achievement of Pupil Sub-groups

Previous sections of this chapter have reported on the Interpretation Panel evaluations of the Grade 12 provincial achievement results. In addition, analyses were conducted with sub-groups of pupils at both the Grade 10 and 12 levels. Descriptions of these sub-groups and their achievement results are reported in this section. Achievement data for each grade are based on the results of an approximately equal number of pupils across both assessment Forms X and Y although the total number of pupils is different for Grades 10 and 12.

5.6.1 Sex-Related Differences in Science

Table 5.10 presents a listing of the previous science course background as well as the current enrollment record in science for Grade 12 pupils. These data are based on a 10% representative sample of the Grade 12 provincial returns. The pattern of results is similar in each section of the table in that boys have a more extensive background and higher enrollment in all science areas except biology. Of particular interest is the finding that 52.6% of the pupils in Grade 12 in March, 1982 were not currently enrolled in any science course, although some of these pupils may have been enrolled in a science course during the Fall semester.

Sex-related differences in achievement were analyzed in terms of objectives, domains, and science content areas. Table 5.11 records how various items in the two assessment booklets were assigned to the four main science content areas.

Table 5.9: Summary of Domain and Objective Ratings for Grade 12

Domain or Objective	Frequencies W	M	S	VS	ST	Mean Percent Correct	Overall Panel Ratings
1. Science Processes							
1.1 Interpret Data	1	5	2	2	0	53.0	M
1.2 Identify and Control Variables	1	4	6	0	1	56.8	S
Domain Total	2	9	8	2	1	55.1	M
2. Knowledge--recall and understand							
2.1 Major Concepts	0	6	9	1	0	52.4	M
2.2 Applications	0	2	3	1	0	59.6	S
2.3 Safety Procedures	2	4	2	0	0	55.6	M
Domain Total	2	12	14	2	0	54.6	M
3. Higher Level Thinking							
3.1 Evaluate Evidence	1	2	2	0	1	58.3	M
3.2 Solve Abstract Problems	2	4	6	0	0	44.7	M
Domain Total	3	6	8	0	1	49.2	M

Table 5.10: Grade 12: Male-Female Enrolment in Previous or Current Science Courses (Percentages)

Course		Previously Taken			Currently Enrolled		
		Male	Female	Total	Male	Female	Total
Science	8	96.2	97.8	97.0	-	-	-
	9	96.1	97.7	96.9	-	-	-
	10	93.1	95.4	94.3	-	-	-
Biology	11	32.6	51.6	42.1	4.0	3.9	3.9
	12	6.3	9.9	8.1	16.1	24.2	20.2
Chemistry	11	33.9	31.7	32.8	5.0	5.6	5.3
	12	5.6	3.8	4.7	20.6	13.4	16.9
Physics	11	30.5	11.9	21.2	7.8	7.6	7.7
	12	4.0	1.2	2.6	15.0	4.4	9.6
Earth Science	11	7.4	4.0	5.7	2.2	0.9	1.5
Geology	12	2.6	1.0	1.8	4.1	2.8	3.5
Not Taking Any Science		-	-	-	48.7	56.3	52.6
Other		10.2	5.6	7.9	9.0	7.1	8.1

		Previously Taken	Currently Enrolled
		Male, N = 1125 Female, N = 1124	Male, N = 985 Female, N = 1039

Table 5.11: Items Contained in Science Content Areas

Content Area	Number of Items	Test Form	Item Number
Biology	20	X	7,10,11,18,19,22,24,26
		Y	2,4,8,10,11,14,15,18,21,22,23,28
Chemistry	13	X	2,4,5,6,8,16,17,28
		Y	1,9,12,25,27
Physics	11	X	25,31,35
		Y	5,6,7,13,20,26,30,31
Earth/Space	12	X	9,14,15,23,30,33,34
		Y	3,19,27,32,33

Table 5.12: Grade 10 and 12 Sex-Related Differences in Achievement

	Mean Percent Correct					
	Grade 10		Difference	Grade 12		Difference
Variable	Male	Female	Male - Female	Male	Female	Male - Female
Content area:						
Biology	48.8	49.9	-1.1	56.7	57.8	-1.1
Chemistry	43.6	41.2	2.4	51.1	46.4	4.7**
Physics	50.0	41.6	7.4**	58.3	43.5	14.8**
Earth/Space	45.9	36.4	9.5**	50.8	41.1	9.7**
Objective:						
1.1 Interpret Data	47.5	44.2	3.3**	56.5	53.3	3.2**
1.2 Identify and Control Variables	49.8	51.7	-1.9	56.6	56.3	0.3
2.1 Science Concepts	49.5	44.5	5.0**	55.3	50.1	5.2**
2.2 Applications of Science (Technology) /Nature of Science	49.9	56.7	-6.8**	60.9	65.0	-4.1**
2.3 Safety Procedures	57.6	49.1	8.5**	61.7	50.3	11.4**
3.1 Evaluate Evidence for Conclusions	58.0	54.6	3.4*	64.2	60.4	3.8**
3.2 Solve Abstract Problems	42.0	35.1	6.9**	49.8	39.0	10.8**
Domain:						
1: Science Processes	48.7	48.0	0.7	56.7	54.5	2.2**
2: Knowledge--recall and understand	51.3	47.8	3.5**	57.7	52.8	4.9**
3: Higher Level Thinking	46.9	41.0	5.9**	54.3	45.4	8.9**
Sample Size		Male N = 955 Female N = 976			Male N = 1122 Female N = 1117	

* p < .05
** p < .01

The mean percentages were higher on all variables at the Grade 12 level compared with Grade 10. Boys' averages at each grade were higher on all variables except on Biology and on the objective Applications of Science (Technology) /Nature of Science. The most reliable sub-scores are those of the three domains. At both grade levels, boys were significantly higher than girls in Knowledge and Higher Level Thinking (p diff $< .01$). However, only at Grade 12 were the boys significantly higher on the Science Processes domain.

5.6.2 Language Background and Science Achievement

Table 5.13 reports the percentage of Grades 10 and 12 pupils who learned English as a first language and also those pupils who now speak English at home.

Table 5.13: Male-Female Language Background by Grade (Percentages)

Language	Grade 10		Grade 12	
	Male	Female	Male	Female
First Learned English	89.4	86.3	84.8	84.3
First Learned Other language	10.6	13.7	15.2	15.7
English Now Spoken at Home	94.8	95.1	93.0	95.7
Other Language Now Spoken at Home	5.2	4.9	7.0	4.3

Table 5.14 reports achievement results in terms of the foregoing language factors. The results are congruent with those of former British Columbia assessments, particularly in Reading. Pupils who spoke English at home achieved higher mean scores than those whose home language was not English.

Table 5.14: Grade 10 and 12: Differences in Achievement by Language Background

Variable	Grade 10 English	Grade 10 Non-English	Difference E - NE	Grade 12 English	Grade 12 Non-English	Difference E - NE
Content Area						
Biology	49.6	43.9	5.7*	57.9	46.4	11.5**
Chemistry	42.6	40.0	2.6	48.8	47.5	1.3
Physics	46.1	38.5	7.6**	51.2	45.5	5.7**
Earth/Space	43.7	38.5	5.2**	46.3	40.2	6.1**
Objective:						
1.1 Interpret Data	46.1	39.7	6.4*	55.5	45.7	9.8**
1.2 Identify and Control Variables	51.3	41.8	9.5**	57.0	47.5	9.5**
2.1 Science Concepts	47.3	41.0	6.3**	53.0	48.0	5.0**
2.2 Applications of Science (Technology)/ Nature of Science	53.7	47.2	6.5	63.3	56.4	6.9*
2.3 Safety Procedures	53.9	42.1	11.8**	56.5	49.0	7.5**
3.1 Evaluate Evidence for Conclusions	56.6	49.5	7.1**	62.7	55.0	7.7**
3.2 Solve Abstract Problems	38.7	34.9	3.8	44.7	40.7	4.0*
Domain:						
1: Science Processes	48.7	41.0	7.7**	56.2	46.5	5.7**
2: Knowledge--recall and understand	49.9	42.1	7.8**	55.6	50.0	5.6**
3: Higher Level Thinking	44.1	39.4	4.7*	50.2	44.9	5.3**
Sample Size	English N = 1833 Non-English N = 98			English N = 2111 Non-English N = 128		

* p < .05
** p < .01

5.6.3 Part-time Employment and Science Achievement

Tables 5.15 and 5.16 report the various aspects of part-time employment of Grades 10 and 12 pupils. Also reported are comparative data from the 1978 Science Assessment. The tables show a greater proportion of Grade 12 pupils compared with Grade 10 pupils have part-time work. Also, it appears that, in 1982, compared with 1978, a slightly higher percentage of pupils are working and they are working for a greater number of hours per week. No significant differences were found between the achievement levels of pupils who did or did not have part-time employment.

Table 5.15: Grades 10 and 12: Part-Time Employment (Percentages)

Question 10: Do You Have a Part-time Job?

Response	Grade 10	Grade 12	
	1982	1978	1982
No	53.6	41.9	39.1
Weekends Only	14.0	NA	17.3
Weekdays Only	4.3	NA	5.1
Both Weekends and Weekdays	20.6	NA	35.2
No Response	7.4	NA	3.2

Table 5.16: Grades 10 and 12: Hours Worked per Week (Percentages)

Number of Hours/Week	Grade 10	Grade 12	
	1982	1978	1982
Less Than 5	16.5	10.5	7.5
5-9	35.5	25.3	28.5
10-20	36.5	39.3	45.8
More Than 20	10.2	19.8	17.4
No Response	0 9	5.0	0.5
Percent of Students Who Did Not Have a Job	53.6	41.9	39.1
N =	1990	26 416	22 110

5.6.4 Achievement in Relation to the Science Background of Pupils

Table 5.17 reports the science content area achievement of Grade 12 pupils differentiated in terms of their amount of science course background. Scheffe's test was applied to the various differences between means and those that were significant ($p < .01$) are reported below the table. The trend of the higher scores to be associated with amount of science background adds positive data in support of the construct validity of the test items.

Table 5.17: Achievement of Grade 12 Pupils Classified by Amount of Science Completed (Mean Percent Correct)

Amount of Science Taken	N	Content Area			
		Biology	Chemistry	Physics	Earth/Space
Science 10 only	710	45.5	32.2	39.6	34.3
One or More Science 11	616	55.8	45.6	49.3	45.2
One or More Science 12	895	69.1	66.2	62.5	56.4
		F=266.5	F=387.7	F=144.0	F=159.5

Scheffe's test applied to the various means above revealed that all combinations of differences in means within content areas were statistically significant ($p < .01$).

Table 5.18 shows a comparison of the mean scores on various science content areas of different groups of Grade 12 pupils and pupils enrolled in Grade 10 who had successfully completed Science 9. Comparing the means of Grade 10 with those of Grade 12 pupils reveals that Grade 10 pupils are above the Grade 12 pupils who have not enrolled in a science course since completing Science 10. However, pupils who have taken one or more science courses in Grades 11 or 12 score higher than the currently enrolled Grade 10 pupils.

5.6.5 Achievement in Relation to Pupils' Future Plans

Tables 5.19 and 5.20 report the mean percentages in various domains for Grade 10 and 12 pupils respectively who have been classified in terms of what they plan to do after leaving secondary school. The classification scheme is a reduction of the 11 possible response categories of Item 12 in the Background Information section of the assessment booklets (see Appendix G). The trends in the data are similar to those obtained from the 1978 Science Assessment results. Scheffe's test was applied to the various differences between means and those differences that were significant ($p < .01$) are reported in Table 5.19.

Table 5.18: Comparison of Grade 10 and 12 Pupils on Science Content Areas

Content Area	Grade 10 Mean	Percentage Difference Between Grade 12 and 10 Means[1]		
		Science 10 Only	One or More Science 11	One or More Science 12
Biology	49.5	- 4.0	+6.3	+19.6
Chemistry	42.5	-10.3	+3.1	+27.7
Physics	45.8	- 6.2	+3.5	+16.7
Earth/Space	41.1	- 6.8	+4.1	+15.3

Grade 10 N = 1941 Grade 12 N = 2221

[1] Differences were calculated by subtracting the Grade 10 from the Grade 12 mean percent correct.

Table 5.19: Achievement of Grade 10 Pupils Classified by Future Plans (Mean Percent Correct)

Pupil Classification	N	Domain		
		Science Processes	Knowledge--recall and understand	Higher Level Thinking
University or College(M_1)	705	54.2	53.5	47.9
Other Post-Secondary Institution(M_2)	499	45.3	48.4	42.9
Look for a Job(M_3)	190	39.8	43.8	38.5
Other Plans or Undecided(M_4)	539	46.7	48.0	41.9
		F = 33.2*	F = 19.9*	F = 14.1*
	Significant Contrasts**	$\underline{M_3\ M_2\ M_4}\ M_1$	$\underline{M_3\ M_4\ M_2}\ M_1$	$\underline{M_3\ M_4\ M_2}\ M_1$

* ($p < .01$)

** Scheffe's test was applied across all combinations of differences in means within domains. Groups sharing a common underlining were not significantly different at $p < .01$.

Table 5.20: Achievement of Grade 12 Pupils Classified by Future Plans
(Mean Percent Correct)

Pupil Classification	N	Domain		
		Science Processes	Knowledge--recall and understand	Higher Level Thinking
University or College(M_1)	758	66.0	64.3	59.6
Other Post-Secondary Institution(M_2)	591	50.3	52.0	45.8
Look for a Job(M_3)	291	45.7	46.7	41.1
Other Plans or Undecided(M_4)	603	53.6	52.0	46.1
		F = 92.7*	F = 85.5*	F = 72.5*
	Significant Contrasts**	$\underline{M_3\ M_2\ M_4}\ M_1$	$\underline{M_3\ M_4\ M_2}\ M_1$	$\underline{M_3\ M_4\ M_2}\ M_1$

* ($p < .01$)

** Scheffe's test was applied across all combinations of differences in means within domains. Groups sharing a common underlining were not significantly different at $p < .01$.

5.6.6 Achievement in Relation to Proposed Post-Secondary Fields of Study

Pupils who plan on entering science careers, compared with those who do not, should attain higher achievement levels in the various areas of science. This proposition was investigated by classifying pupils on the basis of their response to Item 17 in the Background section of the assessment booklets (see Appendix G). Pupils were classified into two groups on the basis of whether or not they anticipated entering a scientific field of study. The achievement levels of the two groups of pupils at both Grades 10 and 12 are reported in Tables 5.21 and 5.22 respectively, and are in the anticipated directions.

Table 5.21: Achievement by Pupils in Grade 10 by Planned Areas of Study (Mean Percent Correct)

Planned Area of Study	N	Science Processes	Knowledge--recall and understand	Higher Level Thinking
Science-related	255	55.8	58.7	53.0
Not Science-related	455	50.3	50.2	44.2
		F = 11.7*	F = 39.4*	F = 29.1*

(Domain spans Science Processes, Knowledge--recall and understand, Higher Level Thinking)

* (p < .01)

Table 5.22: Achievement by Pupils in Grade 12 by Planned Areas of Study (Mean Percent Correct)

Planned Area of Study	N	Science Processes	Knowledge--recall and understand	Higher Level Thinking
Science-related	306	67.8	67.6	65.9
Not Science-related	711	57.6	56.6	49.5
		F = 46.8*	F = 65.4*	F = 111.7*

* (p < .01)

5.7 Comparison of Grade 8 and 12 Pupils on Common Items

Nine common items were used on the Grade 8 and 12 assessment forms. Table 5.23 lists the items along with their p-values as well as the percentage differences between the Grade 12 and 8 p-values. The positive change in achievement between Grade 8 and Grade 12 levels varies from 12% to 33%. All changes imply satisfactory growth over the four-year period and also add evidence to support the construct validity of the test items.

5.8 Comparisons with the 1978 Science Assessment

This section includes three comparative interpretations of the 1978 and 1982 assessment results. Two interpretations are concerned with change items while the third deals with the overall distributions of the Interpretation Panel ratings of all items included in each assessment.

Table 5.23: Grade 8 and 12: P-Values and Their Differences on Common Items

Item Number		P-values		P-value Differences
Grade 12	Grade 8	Grade 12	Grade 8	Grade 12 - Grade 8
1.1.7 (Y08)	1.3.6 (Y24)	56	26	30
1.1.8 (Y11)	1.3.4 (Y08)	80	65	15
2.1.5 (X22)	2.1.19(Y28)	64	38	26
2.1.7 (X26)	2.1.32(Z36)	55	43	12
2.1.13(Y18)	2.1.8 (X31)	63	44	19
2.3.1 (X03)	2.3.6 (Y10)	57	35	22
2.3.5 (Y16)	2.3.12(Z34)	67	34	33
2.3.7 (Y24)	2.3.2 (X18)	64	58	14
3.1.3 (Y03)	3.1.7 (Y09)	48	29	19

Table 5.24: Comparisons Between 1978 and 1982 Change Items Within the Knowledge Domain

1982 Item Number	1982		1978		Percent Difference
	Percent Correct	Panel Rating	Percent Correct	Panel Rating	
X02	47	VS	50	M	-3
X09	43	M	48	M	-5
X12	71	S	63	M	+8
X17	68	S	69	S	-1
X18	54	M	56	W	-2
X26	55	S	54	M	+1
X27	51	S	51	M	0
X29	55	M	53	W	+2
X31	44	S	48	M	-4
Y01	46	S	49	M	-3
Y16	67	M	74	S	-7
Y17	25	W	32	W	-7
Y18	63	M	66	M	-3
Y20	50	S	51	M	-1
Y27	46	M	52	S	-6
Mean	52.4		54.3		-2.1
Standard Error of the Mean	0.3		0.2		

The 1982 Science Assessment forms included items selected from the previously used 1978 booklets. These items, called change items, totalled 27. Fifteen were from the Knowledge domain and 12 were from the Higher Level Thinking domain. The latter included all items for Objective 3.2 Solve Abstract Problems.

Tables 5.24 and 5.25 show the mean percent correct and the Panel ratings for each item. In both tables, the mean percent difference over all items was less than two percent higher in 1978 than in 1982. Although from a practical point of view this difference may seem small, the difference would be statistically significant as evidenced by the small standard errors of the means. The column in each table entitled "Percent Difference" is for the purpose of identifying items of interest for futher study.

Table 5.25: Comparisons Between 1978 and 1982 Change Items Within the Higher Level Thinking Domain

1982	1982		1978		Percent Difference 1982 - 1978
Item Number	Percent Correct	Panel Rating	Percent Correct	Panel Rating	
X11	50	S	54	M	-4
X24	48	M	47	W	+1
X25	58	S	57	M	+1
X28	45	S	44	M	+1
X34	31	W	38	W	-7
Y10	51	S	48	M	+3
Y12	37	W	41	W	-4
Y13	43	M	41	M	+2
Y19	40	S	48	S	-8
Y25	33	M	37	W	-4
Y30	64	S	60	M	+4
Y32	36	M	38	M	-2
Mean	44.7		46.1		-1.4
Standard Error of the Mean	0.2		0.3		

Even though the mean percent correct over all items was lower in 1982, the Interpretation Panels in 1982 rated the pupil performance higher. This conclusion is based on the ratings shown in both tables where, in 1982, 14 of the 27 items were ranked "Satisfactory" or higher whereas in 1978 only four items were ranked "Satisfactory" and none were ranked higher than "Satisfactory". This situation, where Grade 12 achievement over a four-year period shows a decline in mean percent correct but an increase in the evaluative judgement of the achievement level, needs further investigation.

In order to judge the overall achievement levels of Grade 12 pupils in 1982 compared with 1978, tables were made of the panel ratings of all items used in each of the assessments. In 1978, 71% of the 120 items were rated below "Satisfactory" whereas in 1982, 49% of the 70 items were rated as below "Satisfactory". As such, if one assumes the items had high curricular validity and were representative of the junior secondary science curriculum, then the 1982 results can be considered better than those of four years earlier.

In summary, although the percentage correct on change items showed a slight decrease in 1982 compared with 1978, the 1982 Interpretation Panel ratings were higher. Also, when the proportions of Interpretation Panel ratings on all assessment items were compared, the 1982 ratings appeared higher.

5.9 Pupil Attitudes/Interests/Opinions

In an attempt to judge the attitudes and opinions of Grade 10 and 12 pupils toward various non-cognitive aspects of science, the following short scales were placed at the beginning of the achievement survey booklets as shown below.

Form X

- School Science
- Scientists
- Science and Society

Form Y

- Careers in Science
- Methods of Science
- Specific Issues

Brief descriptions of the attitude/opinion/interest instruments are found in Section 2.3 and the actual questionnaires along with the provincial results are reprinted in Appendix G. The remainder of this chapter begins with a discussion of the Grades 10 and 12 results of the School Science scale and then interprets the results of the other instruments in the order they are listed above. With certain interpretations, the Grade 8 results will also be discussed along with those of Grades 10 and 12.

5.9.1 School Science Scale

In the School Science scale the percentile equivalent of score 30 divides the scale into the negative and positive sections. Note that at the Grade 10 and Grade 12 levels respectively, 75% and 68% of the pupils scored on the positive side of the scale. There is very little shift in attitudes between Grades 8 and 10. However, at the Grade 12 level, where pupils are beginning to clarify their vocational goals, more are expressing negative attitudes toward science in school.

Table 5.26: Attitudes Toward School Science in Relation to Various Independent Variables

Variable	Grade/Category	N	Mean	F
Gender	10 Male	483	3.40	.206
	10 Female	473	3.42	
	12 Male	544	3.36	.602
	12 Female	584	3.33	
First Language Spoken	10 English	840	3.38	9.995*
	10 Another Language	116	3.61	
	12 English	944	3.32	5.981*
	12 Another Language	183	3.46	
Language Now Spoken at Home	10 English	906	3.40	5.297*
	10 Another Language	52	3.63	
	12 English	1061	3.33	3.417*
	12 Another Language	64	3.51	
Part-time Job	10 No	531	3.44	1.275
	10 Yes	374	3.38	
	12 No	435	3.38	2.650*
	12 Yes	683	3.31	
Future Plans	10 University	357	3.69	40.260*
	10 Training	245	3.36	
	10 Job	79	2.88	
	10 Other	276	3.28	
	12 University	377	3.66	44.898*
	12 Training	285	3.26	
	12 Job	147	3.00	
	12 Other	311	3.22	

* $p < .01$

5.9.1.1 Attitudes Toward School Science in Relationship to Various Reporting Categories

A variety of univariate analysis of variance tests was conducted using the School Science scores as the dependent variable and pupils classified into various categories as shown in Table 5.26. Of interest are the data which shows that not only pupils whose first language learned was not English but also those whose current language spoken at home is not English had higher scores than the majority groups. This finding requires further study.

Table 5.27 reports correlation coefficients between School Science and various science achievement measures. The pattern and size of the coefficients at the Grade 8 and 10 levels are very similar. However, at Grade 12, the size of the coefficients shows a large increase. These increases are possibly due to the dichotomized sample of pupils in Grade 12 when a relatively large group have chosen science as a future career.

Table 5.27: Product-Moment Correlations Between Attitudes Toward School Science and Various Achievement Measures Across Grades*

		Achievement Measures			
Grade Form	N	Domain 1 Science Processes	Domain 2 Knowledge...	Domain 3 Higher Level Thinking	Booklet Total Score
8Y	1034	.22	.27	.17	.27
10X	986	.19	.25	.19	.25
12X	1162	.38	.44	.36	.46

* All correlations are statistically significant at the .01 level.

5.9.2 Attitude Toward Scientists

In the Attitude Toward Scientists scale the percentile equivalent of score 30 divides the scale into the negative and positive sections. At Grades 10 and 12, 89% and 87% respectively of the pupils scored on the positive side of the scale. Pupils at all grade levels appear to have a very high positive attitude toward scientists as people.

5.9.3 Attitudes Toward Science and Society

In the Science and Society scale, the percentile equivalent of score 36 divides the scale into negative and positive regions. Eighty-nine percent of the Grade 10 pupils and 90% of the Grade 12 pupils attained scores on the positive side of the scale. One can conclude, therefore, that at these grade levels, pupils' attitudes toward the place of science in society is very positive.

5.9.3.1 Sex-Related Differences in the Attitudes Toward Science and Society Items

A Chi-square analysis was performed on each item to determine differences in patterns of responses between male and female pupils. Only two items were statistically significant at the grade level. In Item 2, 19.3% of the males and 11.4% of the females strongly disagreed with the proposition that scientific research should not get any of the taxpayers money.

Item 12 showed a statistically significant pattern difference at both Grades 10 and 12.

More study of the response patterns reveals that the Grade 12 pupils claim to use scientific ideas or facts more in their everyday life than do younger pupils.

5.9.4 Attitudes Toward a Career in Science Scale

In the Careers in Science scale, the percentile equivalent of score 30 divides the scale into negative and positive sections. Note that at the Grade 10 and 12 levels only 49% and 50% respectively, of the pupils scored on the positive side of the scale. Pupils at all grade levels assessed do not appear to have a high interest in pursuing a career in science. This conclusion is very unfortunate in view of the probable increased need for technically and scientifically trained male and female personnel in our present and future work force.

5.9.4.1 Sex-Related and Other Differences

An analysis of variance test revealed a non-significant difference in the relatively low mean scores of boys and girls on the Careers in Science scale at both Grade 10 and 12 levels. Two items showed significant sex-related differences. An examination of the item-response patterns indicated that the majority of pupils are not interested in pursuing a career in science and would not be satisfied with the life of a scientist.

It is also interesting to note that, once again, at both grade levels, girls are more negative than boys to the idea of pursuing a scientific career. Science teachers and guidance counsellors are encouraged to study the possible causes of these results and offer suggestions on how to improve the attitudes of students toward pursuing a scientific career.

5.9.5 Attitudes Toward the Methods of Science Scale

The Methods of Science scale was administered only at Grades 10 and 12. As shown in Table 2.9, the Hoyt internal-consistency reliability estimate was .50 for each grade. Although this value is sufficiently high for measuring group differences in average scores, it is of interest to contemplate why it is so low compared with other scale estimates.

The Methods of Science scale had the highest of all the attitude mean scores. However, it also showed the lowest spread of scores at each grade level. This latter fact had a great influence in depressing the reliability estimates because the size of a reliability coefficient tends to increase as the standard deviation increases.

A study was conducted to determine the amount of variablitiy of pupils responses within each item. Interestingly, on all items at both grade levels, there was a very large modal response situated on one or the other side of the "Can't Decide" category. Pupils, therefore, tended to answer the questionnaire in pattern that is seen in typical True-False test results. A study of the content of the items shows they contain a very high cognitive component and thus the item statements did not permit or promote a broad emotional reaction that is necessary for affective measures.

As a result of the foregoing factors, one may conclude that both Grade 10 and 12 pupils are very knowledgeable about the methods of science as measured by the questionnaire. However, the intent of measuring attitudes towards methods of science was not realized.

5.9.6 Specific Issues in Science

This section, which concludes the chapter, presents sex-related differences over three grades on selected responses to ten statements on current issues in science and technology. Sample sizes used in the various grades are as follows:

Gender	Grade 8	Grade 10	Grade 12
Male	531	476	579
Female	497	502	541

Unlike the attitude measures previously reported in the chapter, the items addressing Specific Issues do not constitute a scale. Therefore, selected responses to each individual Specific Issues item are reported. All figures given in the items are percentages of students responding to the category.

1. STUDENTS SHOULD LEARN HOW TO USE COMPUTERS

	Grade 8		Grade 10		Grade 12	
	Agree	Strongly Agree	Agree	Strongly Agree	Agree	Strongly Agree
Male	48	34	53	24	61	18
Female	61	17	63	16	62	17

There is no doubt that pupils find the thought of learning how to use computers very appealing as shown by approximately 80% agreeing or strongly agreeing with the statement. The large positive respose could have been influenced by the current micro-computer craze, the attraction of video games, and/or the intrinsic motivational appeal that computers have for many pupils.

7. WE SHOULD GET BACK TO A SIMPLER WAY OF LIFE BY GETTING RID OF ALL THIS TECHNOLOGY

Grade	Gender	Strongly Disagree/Disagree	Can't Decide	Agree/Strongly Agree
8	Male	71	14	15
8	Female	58	20	22
10	Male	78	9	13
10	Female	62	17	21
10	Male	77	10	13
10	Female	64	17	19

Pupils appear to have a strong appreciation of the place of technology in today's world and boys seem to have considerably more faith in technology than do girls.

4. HIGHWAY SPEED LIMITS SHOULD BE MADE LOWER SO THAT WE CAN SAVE GASOLINE

	Grade 8		Grade 10		Grade 12	
	Strongly Disagree	Disagree	Strongly Disagree	Disagree	Strongly Disagree	Disagree
Male	19	42	18	50	20	53
Female	10	53	10	55	9	57

In the battle of conservation and economy vs speed--speed wins. No doubt this is an emotional issue which involves the importance of the automobile in our society, particularly its influence on young people. Do pupils actually understand the relationship between speed and gasoline consumption? If they do, then one must wonder whether their responses show a lack of concern for resources or whether their need for a thrill overpowers other considerations.

6. WE CAN USE ALL THE NATURAL GAS, OIL AND GASOLINE WE NEED NOW BECAUSE FUTURE GENERATIONS WILL FIND NEW FORMS OF ENERGY.

Grade	Gender	Strongly Disagree/Disagree	Agree/Strongly Agree
8	Male	75	17
8	Female	75	12
10	Male	75	15
10	Female	85	9
12	Male	74	19
12	Female	83	7

On first glance, the results appear to favor conservation. However, when compared with the results of Item 4, the results are inconsistent. In particular, the boys may be saying that others should conserve but don't slow down our cars. On the other hand, boys may have more faith in science to solve our future problems. Items 3, 8 and 10 are concerned with various environmental issues.

Considering Item 3, some individuals will claim that the statement is ambiguous, others that the topic is highly controversial. Perhaps there is truth in both claims as pupils appear very ambivalent in their choices. The "Can't Decide" responses are quite similar over the grades with girls less willing to take a stand on the issue. However, older pupils show an increase in their favorable ratings toward nuclear plants--boys more so than girls. The latter fact may reflect more reading of technological (pro-nuclear) material by boys.

3. ELECTRICAL GENERATORS POWERED BY COAL AND OIL CAUSE LESS POLLUTION THAN NUCLEAR PLANTS

Grade	Gender	Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
8	Male	11	26	26	28	9
8	Female	3	28	33	32	4
10	Male	13	33	24	22	9
10	Female	5	28	35	28	4
12	Male	15	35	20	21	8
12	Female	7	33	31	25	4

8. FACTORIES SHOULD BE REQUIRED TO REDUCE SMOKE POLLUTION EVEN IF PRICES GO UP

	Grade 8		Grade 10		Grade 12	
	Agree	Strongly Agree	Agree	Strongly Agree	Agree	Strongly Agree
Male	42	35	48	36	44	38
Female	50	20	47	29	57	25

The statement in Item 8 appears easy to agree with, particularly amongst young people who haven't been confronted with meeting the challenge of higher prices.

10. FARMERS AND RANCHERS SHOULD BE ABLE TO USE ANY CHEMICAL SPRAYS THEY THINK ARE NECESSARY

	Grade 8		Grade 10		Grade 12	
	Strongly Disagree	Disagree	Strongly Disagree	Disagree	Strongly Disagree	Disagree
Male	28	48	31	50	39	47
Female	32	49	37	52	43	47

In Item 10 the pupils took a strong anti-pollution stance which increased with age and was more apparent among females.

5. SCIENTISTS SHOULD CONDUCT EXPERIMENTS ON ANIMALS IF THEY THINK PEOPLE WILL BE HELPED

	Grade 8			Grade 10			Grade 12		
	Can't Decide	Agree	Strongly Agree	Can't Decide	Agree	Strongly Agree	Can't Decide	Agree	Strongly Agree
Male	14	47	17	15	52	15	10	58	15
Female	12	43	14	17	47	10	16	53	9

Students basically agree with Item 5 and a slight increase is noted by grade. Probably, older pupils are more aware of the potential benefits of animal research. Males are consistently more in favor of animal experiments while females may be more sensitive to possible animal suffering.

2. SCIENTISTS SHOULD DO MORE RESEARCH ABOUT CREATING LIFE IN THE LABORATORY

Grade	Gender	Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
8	Male	4	17	34	38	7
8	Female	3	17	42	35	3
10	Male	6	25	38	27	4
10	Female	5	26	37	28	3
12	Male	9	30	32	24	4
12	Female	8	29	37	24	1

The statement in Item 2 poses a complex issue and the results may reflect the mixed feelings of society at large. The modal response of "Can't Decide" is generally over one-third of the pupils across the grades. Older students, with their increasing percentage of disagreement, may be more aware of the dangers of genetic engineering. They also may be less willing to trust others on moral issues. Under the guidance of a capable teacher this could prove to be an excellent topic for research and discussion in the classroom.

9. PEOPLE SHOULD BE CRITICAL OF COMPANIES' CLAIMS THAT THEIR MEDICAL DRUGS ARE SAFE

Grade	Gender	Can't Decide	Agree	Strongly Agree
8	Male	23	52	16
8	Female	24	50	19
10	Male	18	54	20
10	Female	17	52	27
12	Male	15	56	24
12	Female	15	57	26

In Item 9, the shift over the grades from the "Can't Decide" response toward agreement with the statement may reflect a healthy skepticism as well as greater consumer consciousness. However, from the companies' point of view one may ask whether pupils know about the types of testing that is carried out, or about the various federal government safeguard regulations.

CHAPTER 6

ELEMENTARY TEACHER QUESTIONNAIRE RESULTS

John Sheppy

6.1 Development and Description of the Questionnaire

In order to identify the current context of science teaching in British Columbia, to document current classroom practices, and to assess changes since the 1978 B.C. Science Assessment, data were sought from teachers of elementary science through the use of a questionnaire. The questionnaire developed was a modification of the one used in 1978. Many questions were retained unchanged or with minor alterations. A few were changed substantially. Occasionally, a question was split into two, or two questions were combined into one. Of the 61 original questions, eight were dropped from the 1982 questionnaire and eight new questions were added. Changes were made in the wording of the previous questions, to modify the choice categories, or to reflect changes of content and context of elementary school science. Thirty-nine of the questions, some with minor changes, also appeared on the questionnaire for teachers of secondary science.

The teachers' responses to the questionnaire and their implications are discussed in Sections 6.3-6.11 of this chapter which, with a few exceptions, follow the questionnaire categories. The chief recommendations are collected in Section 6.12. The questionnaire appears in Appendix H of this report. Unless otherwise stated, numbers shown are the ranked percentages of teachers who responded to each option. The base for the percentage calculation does not include teachers who omitted the question. The number of omissions was small (approximately 10-30) for most one-part questions, but was sometimes high (over 100) for complex questions. No discussion is devoted to the section on Grade-Specific Information since it was only used to ask teachers to identify a grade level perspective from which to answer the last two sections of the questionnaire.

6.2 Description of the Sample of Elementary School Teachers

The population from which the sample was chosen initially included all teachers who, in the Fall of 1980, indicated on Form J (now Education 2001) that they registered at least one of Grades 1 to 7. The selection process then excluded all principals, vice-principals, and school district staff, and any teacher who had been previously selected to answer a Science Council of Canada Science and Education Study questionnaire. The remaining 9991 teachers were divided into seven mutually exclusive groups by the grade or one of the grades which they registered. Approximately one-sixth of the teachers were selected from the lists created. From a random start on each list, every sixth succeeding name was selected, resulting in a sample of 1614 teachers.

Questionnaires with the selected teachers' names on the covering envelopes were mailed to the schools. The principal was instructed to give the questionnaire to the indicated teacher unless the teacher was no longer in the school or was not teaching science. In these cases, the principal redirected the questionnaire to an alternate teacher at the same grade level. Teachers were instructed to remove their names from the covering envelope prior to returning the questionnaire, so that returns were anonymous. Eighty-two percent (1322 teachers) of the sample returned the questionnaire.

All groups concerned with the Assessment wish to acknowledge the care with which the questionnaire was completed, the thoughtful comments which were made, and the high return rate of the questionnaire.

In 1978, three percent of the teachers surveyed reported that they taught no science. In the 1982 Assessment, such teachers were excluded from the survey. Since teachers were selected on the basis of the 1980 Form J data rather than from 1981 data, teachers new to a school, including all first year teachers, were systematically excluded from the survey unless they were asked by the school principal to act as alternates.

6.3 Teacher Background and General Information

The first section of the questionnaire asked teachers questions regarding their personal, educational and professional backgrounds, and about the school situation in which they taught. Seven questions were used to obtain this information.

6.3.1 Experience, Gender, and Age

Question 1 asked teachers to report the number of years of teaching experience they possessed. The median value reported was just over ten years. In 1978, the median number of years teaching reported was just over eight years.

Table 6.1 shows that, in 1978, 36% of the teachers had five or fewer years experience; now only 24% have five or fewer years.

Direct comparison of the more experienced teachers is not possible because of changes made in the questionnaire but, in 1978, 28% of the teachers had 14 or more years of experience; now 30% have 15 or more years.

Question 2, which asked teachers to indicate their gender, shows that 62% of the respondents were female and 38% male. The 1978 survey showed 33% male. One cause for the increase in the number of male teachers could be a significant increase in the number of males teaching in B.C. elementary schools; an alternative cause could be that more males were specializing in science teaching in 1982 than in 1978.

Table 6.1: Years of Teaching Experience in 1978 and 1982

1978		1982	
Years of Teaching Experience	Percent of Teachers	Years of Teaching Experience	Percent of Teachers
1 or less	6	1-2	8
2-5	30	3-5	16
6-9	20	6-10	26
10-13	16	11-15	19
14 or more	28	More than 15	30

The results of Question 27, tabulated by gender, clearly show that male teachers are used as science specialists to a greater extent than females. This finding is consistent with the better science backgrounds of males which is discussed in Section 6.3.2. The absolute numbers reinforce the picture shown by the percentage figures; 195 males and only 95 females reported teaching other science classes in addition to their own.

Question 3 requested that teachers indicate their ages. The age figures show a similar trend to the experience values. The median age in 1982 was a little less than 36 years and in 1978 it was a little over 33 years. The data also showed 34% of the teachers under age 30 in 1978, with only 22% being under age 30 in 1982. While 30% were 40 or over in 1978, in 1982, 35% were 40 or older.

Comparisons of data for elementary, junior secondary and senior secondary teachers (as shown on the questionnaires in Appendices H and I) show that the age distributions for elementary and junior secondary school teachers in 1982 were very similar, while, on the average, senior secondary teachers were older.

Tables 6.2 and 6.3 compare the ages and experience of male and female teachers.

Table 6.2 indicates that, on the average, male teachers of elementary school science are more experienced than female teachers by about three years: the male median is 12.5 years. the female median is 9.6 years. Table 6.3 indicates that males are older by about 1.5 years: the male median is 36.8 years, the female median is 35.1 years. The career pattern of teachers seems to be that, on the average, women start teaching younger than men, and during their early years have more experience for their age than do men. Later, many drop out for periods of time so that in later years of teaching men have more experience for their age than do women. Thirty-six percent of women between 25 and 29 years old have six to ten years experience, but only 18% of the men in this age bracket have as much, whereas 96% of the men 50 years old or older have more than 15 years experience, while the corresponding figure for women is 83%.

Table 6.2: Percentages of Male and Female Teachers by Years of Teaching Experience

	Years of Experience				
Gender	1-2	3-5	6-10	11-15	over 15
Male(n = 499)	6	13	26	19	37
Female(n = 802)	9	18	27	19	25

Table 6.3: Percentages of Male and Female Teachers by Age Group

	Age					
Gender	24 or younger	25-29	30-34	35-39	40-49	50 or over
Male(n = 499)	2	13	25	23	24	14
Female(n = 802)	6	21	21	19	21	13

The above analysis shows that the typical elementary science teacher in B.C. is about 36 years old and has about 10 years of experience. The teaching force is now more mature and more experienced than in 1978. Consequently, teachers are, on the average, more distant in time from their initial training.

Question 4 attempted to assess the breadth of teaching background of teachers. The responses show that very few people are concurrently teaching elementary school science and science at the secondary or other levels (a total of three individuals in the sample), but that a substantial number (eight percent) of elementary teachers have taught at the secondary level in the past. Only 1.5% of the sample is concurrently teaching both primary and intermediate level science. Fourteen percent of the sample have taught at the primary level, but are now teaching at the intermediate level, while 10% of the sample have moved from the intermediate level to the primary level. For comparison, data from the secondary teacher questionnaire indicated that more than 20% of the secondary science teachers have taught elementary school science.

6.3.2 Educational Background

Question 5 attempted to assess the educational preparation of elementary teachers for the task of teaching science. A problem arose from the failure of respondents to indicate a category on each line of the question; indeed, for the fifth line, 58.5% of the respondents indicated no category. An examination of a sample of the questionnaires showed that less than one percent failed to indicate any courses taken, about 30% answered the question as intended, and about 70% indicated categories on some questionnaire lines only. Study of these cases causes the interpreters to infer that missing data in this question are best interpreted as indicating that no course was taken in the area. The data in Appendix H are adjusted to give percentages only of those who responded. Table 6.4 shows the percentage of the total sample responding with the assumption indicated above.

Comments will be made in succeeding parts of the report regarding teachers' preparation in courses in the teaching of science.

Table 6.4: Percentage of Elementary Teachers Reporting Numbers of University Courses Completed in Sciences

Area of Study	University Courses Completed				
	None or No Response	Less than One	One (3 units)	Two or Three	Four or More
The Teaching of Science	21	9	50	18	2
Biological Science	50	3	28	12	7
Earth/Space/General Science	53	3	29	11	4
Physical Science	63	3	19	11	5
Other Science	87	1	5	4	3

Each of the elementary science options available to British Columbia elementary school teachers places emphases upon three major areas of science: the biological sciences, the physical sciences, and the earth/space sciences. The above table shows that no more than half of the teachers have university level education in any of these areas.

To examine this problem more closely, Table 6.5 was prepared. It shows the percentage of teachers reporting different total numbers of science courses.

Table 6.5: Percentage of Elementary Teachers Reporting Total Numbers of University Science Courses Completed

Number of Courses Completed	Percent of Teachers
None	23
Less than One	2
One or equivalent (3 units)	26
Two or More	49

Twenty-five percent of the teachers reported they had taken less than one 3-unit university/college level science content course. This indicates a serious deficiency in the preparation of elementary school teachers when one considers that science is one of the major areas of human activity, is one of a limited number of ways of knowing, and is a major force in the social fabric of our times. It is encouraging that nearly 50% of the teachers have at least two university level science courses, although multiple courses are often all in the same area.

Considering the factors mentioned above, the Contract Team recommends that:

- the Faculties of Education in British Columbia revise teacher education programs as needed to ensure that all new elementary school teachers experience science study to a minimum of a 3-unit course or equivalent at the university/college level
- the Ministry of Education revise certification guidelines to reflect the above

Table 6.6 shows the percentages of males and of females who indicated that they had taken two or more courses in each of the areas listed in Question 5. These data show that a higher percentage of male teachers are well trained in science and in science teaching. Although female teachers are more numerous in schools than males, the actual number of males with superior training exceeds that of females.

Table 6.6: Percentages* of Male and Female Elementary Teachers with Two or More Courses (6 Units or More) in Different Science Areas

Gender	Teaching Science	Biological Science	Earth/Space General Science	Physical Science	Other Science
Male	27	26	25	26	14
Female	16	15	9	8	3

* Percentages may sum to more than 100 due to multiple course concentrations.

The above data are indicative of the problem recently emphasized by the Science Council of Canada's 1982 publications, Who Turns the Wheel? and The Science Education of Women in Canada: A Statement of Concern, that science is stereotyped as a male activity. Even at the elementary school level, the best prepared science teachers that girls encounter are likely to be male and, if the class is taught science by someone other than the homeroom teacher, that person is far more likely to be male. Because of these factors, it is strongly suggested that secondary schools and universities encourage women who are interested in science to consider elementary school teaching. Ways should be sought in which women preparing to be elementary school teachers can become interested in science.

Question 6 requested information about the recency with which a methods course in the teaching of science was taken.

The data from Questions 5 and 6 indicate that somewhere between 18% and 21% of the teachers now teaching elementary science have never taken a methods course. This is a substantial increase over the eight percent who so indicated in 1978 and may reflect recent changes in the patterns of teacher preparation in British Columbia.

The in-service implications of the remainder of the data from question 6 are considered in Section 6.7.2 of this report.

6.3.3 School and Class Size

Question 7 asked teachers to report on the size of school in which they worked. Nearly two-thirds of the teachers are in schools of 250-500 students. Only 11% are in larger schools, and 28% are in smaller schools.

Question 42 asked teachers to report on the size of their largest science class at the grade level they had indicated in the Grade-Specific Information section. For most teachers, this would be the size of their own class, although 22% of the teachers surveyed did teach science to classes other than their own. The data are shown in Table 6.7.

Table 6.7: Percentage of Elementary Teachers by Grade Level and Size of Largest Science Class

Size of Largest Science Class	Grade							All Grades	
	1	2	3	4	5	6	7	1978	1982
20 or Fewer	27	22	23	11	9	7	5	14	15
21-24	60	51	36	15	20	14	12	25	30
25-28	12	22	35	46	42	39	41	33	33
29-32	0	2	6	23	23	35	34	22	18
over 32	0	2	0	5	6	4	7	6	4
Number of Teachers	210	184	204	160	182	178	209		

Table 6.7 clearly shows that there are more smaller classes and fewer large classes in science now than in 1978. It also shows that primary level classes are likely to be smaller than intermediate classes.

When the data from Question 42 were analyzed in terms of school size, the analysis showed that smaller classes are far more common in smaller schools.

6.4 Coordination

The 1978 Science Assessment strongly recommended that there be formally designated science coordinators at the district level and in larger elementary schools. In order to assess the current situation, the four questions about leadership used in 1978 were asked again in 1982 with only minor changes.

6.4.1 Coordination Within Schools

Teachers were asked to indicate the form of coordination existing in their school in Question 8, and to rate this form of coordination in Question 9. Tables 6.8 and 6.9 summarize the data for both Assessments.

Table 6.8: Percentage of Teachers by Form of Science Coordination in Elementary Schools (1978 and 1982)

Form of Coordination	1978	1982
Designated coordinator	8	7
Working group of teachers	12	11
Assumed by school administrator	17*	7
Assumed by teacher		16
No form	60	57
Other	3	

* In 1978 these two categories were combined in a single response category.

Table 6.9: Elementary Teacher Ratings of Adequacy of School Science Coordination (1978 and 1982)

Rating	Percent of Teachers 1978	1982
Excellent or Very Good	16	12
Satisfactory	54	53
Unsatisfactory or Very Unsatisfactory	31	35

It is evident that there have been only small changes in the last four years and these have been achieved mostly by individuals assuming coordination responsibilities. Most teachers in both Assessments reported no form of school coordination. This situation contrasts with that at the secondary school where formal coordination exists in nearly 90% of the schools.

Less than one teacher in eight rates the in-school coordination being received as better than satisfactory, and 35% of the teaching force are dissatisfied. In order to examine whether dissatisfaction lay in the quality of coordination being received where there was leadership, or lay in the lack of leadership, Table 6.10 was prepared.

Table 6.10: Elementary Teacher Ratings of Adequacy by Form of School Science Coordination

Rating	Form of Coordination (Percent Experiencing that Form)				
	Designated Coordinator	Group of Teachers	Assumed by Administrator	Assumed by Teacher	No Form
Excellent or Very Good	31	24	19	22	2
Satisfactory	59	65	73	61	43
Unsatisfactory or Very Unsatisfactory	9	11	8	17	55

Table 6.10 shows that where coordination exists, it is well received by the majority of teachers, and that formal coordination produces greater satisfaction than does informal coordination. Where no coordination exists, 55% of the teachers find the situation unsatisfactory at best.

6.4.2 Coordination in School Districts

Similar questions were asked about science coordination at the school district level and the results are summarized below in Tables 6.11 and 6.12.

Table 6.11: Percentage of Elementary Teachers by form of Science Coordination in School Districts (1978 and 1982)

Form of Coordination	1978	1982
Designated coordinator	32	42
Working group of teachers	19	17
Assumed by administrator or teacher	8	6
No form	38	33
Other	4	2

Table 6.12: Elementary Teacher Ratings of Adequacy of District Science Coordination (1978 and 1982)

Rating	Percent of Teachers	
	1978	1982
Excellent or Very Good	15	18
Satisfactory	51	47
Unsatisfactory or Very Unsatisfactory	34	35

A larger number of teachers experience coordination at the district level than at the school level. There has been a significant increase in such coordination since 1978, and detailed examination of the questionnaire results from both Assessments shows that this increase has occurred in each of the three forms of designated coordination: elementary science coordinators, elementary-secondary science coordinators, and coordinators of science with other subjects. However, one-third of the teachers still report no coordination. Despite the increase in coordination, the degree of satisfaction remains much the same as in 1978. To examine the source of dissatisfaction, Table 6.13 was prepared.

Table 6.13: Elementary Teacher Ratings of Adequacy by Form of District Science Coordination

	Form of Coordination (Percent Experiencing that Form)			
Rating	Designated Coordinator	Group of Teachers	Assumed by Administrator or Teacher	No Form
Excellent or Very Good	31	19	5	0
Satisfactory	57	64	50	24
Unsatisfactory or Very Unsatisfactory	12	17	45	76

It is evident that teachers find any form of coordination at the district level preferable to no coordination. Formal coordination is superior to informal (assumed) coordination and designated individual coordinators are preferred to coordination by groups. It would seem that the greater the degree of assigned responsibility, the higher the satisfaction of teachers with the job done. Where no coordination exists, three-quarters of the teachers express dissatisfaction. Where the job of coordinating science has been informally assumed, the responses of teachers indicate the results have not been uniformly satisfactory. This lack of uniformity could relate either to the time and facilities available to the informal coordinator or to the suitability of the individual to the task.

Table 6.14 was constructed to examine the degree of correlation between the forms of leadership at the two levels.

Table 6.14: Form of Elementary School Coordination by Form of District Coordination

	Form of District Coordination			
Form of School Coordination	Designated Coordinator	Group of Teachers	Assumed by Administrator or Teacher	No Form
Designated coordinator	12*	5	3	1
Group of teachers	12	14	7	9
Assumed by administrator	5	11	15	7
Assumed by teacher	23	17	8	8
No form	47	52	66	75

* Figures are rounded percentages

Where formal district coordination exists, there is more likely to be some form of coordination within the school than where there is either informal or no district coordination. It is still a matter of concern that, even where formal district coordination exists, one teacher out of two experiences no in-school coordination. Where no form of district coordination exists it is highly probable that there will also be no form of school coordination. Table 6.11 in conjunction with Table 6.14 reveals that nearly one teacher in four reports experiencing neither district nor school leadership in science instruction.

Based on the above analysis, the Contract Team believes that coordination and leadership in elementary science in the schools of British Columbia should be a matter of concern to districts. There has been little progress in this area during the past four years. It is evident that teachers are looking for coordination in science and are much more satisfied when coordination exists.

Therefore, the Contract Team recommends that:

- districts appoint or designate a qualified individual to be responsible for coordination of the elementary science program within the district
- districts and schools evaluate the form of science coordination within each school and establish some form of school-level coordination where none now exists

These recommendations are similar to those made in 1978, and the Contract Team finds it discouraging that so little progress has been made in this area.

6.5 Physical Facilities, Materials and Equipment

The third section of the questionnaire sought to obtain teachers' perceptions of the physical environment in which science teaching takes place. Eleven questions were asked in this category.

6.5.1 Structural Facilities

Question 12 asked teachers to rate the adequacy of 16 physical features of classrooms according to five categories. The data are shown in Appendix H. The similar question in 1978 (Question 5) used a different numerical scale, so direct comparisons are not possible, although qualitative comparisons can be made.

In general, the standard classroom facilities--lighting, flat-topped desks or tables, ventilation, chalk board, and bulletin board space--were reported to be adequate or better by most teachers. (Some teachers seem to have interpreted "lighting" as meaning specials kinds of lamps and rated this as "Not Required".) The Contract Team is concerned that nearly 40% of the teachers reported deficiencies in classroom facilities (i.e. inadequate ventilation or appropriate desks and tables not available).

Sinks, water outlets, and electrical outlets, essential for a good science program, were rated as adequate or better by slightly less than half of the teachers. In more than half the classrooms in which science is taught, these features are still missing or inadequate.

In 1978, space for storage and preparation, as well as student work space, was reported to be inadequate by most science teachers. There seems to have been little change since that time. Only one teacher in three rated storage space for science materials as adequate. Storage space for student projects was even less available. While 67% of the teachers perceived a need for special storage for dangerous materials, 40% of them rated such storage as inadequate or missing. Three teachers in four felt that a science preparation room was needed, and less than one in ten felt the present facility was adequate. Work space for students fared better than other space items, but was still felt to be adequate by only

40% of the teachers. A frequently recurring comment in the free response section was the need for a special science room. In Section 6.10.4 it is shown that teachers rate the provision of such a room as one of the changes most likely to produce improvement in science instruction.

Question 20 requested information regarding the location of storage facilities in the school. Table 6.15 compares 1982 to 1978 responses for this question.

Table 6.15: Location of Science Materials/Equipment Storage in Elementary Schools, 1978 and 1982 (percentages)

Location	1978	1982
Convenient central storage room	37	41
Inconvenient central storage room	22	28
Distributed throughout the school	28	18
Designated classrooms	10	9
Other	5	4

The 1978 Science Assessment Report recommended the establishment of central storage in each school as the most satisfactory method of storage. It is encouraging to note that there has been an improvement from 59% (1978) to 69% (1982) of the teachers reporting such a facility, with a corresponding decrease in the number of teachers reporting that equipment is scattered throughout the school. However, there are still a large number of schools without convenient central storage. Among comments made by teachers in the free response section of the questionnaire, the third most common comment was that classroom and storage space was inadequate for the kind of teaching job the teacher wished to do.

The 1978 Assessment Report suggested ways in which the classroom space becoming available through declining enrollments could be utilized to improve the facilities and space deficiencies which were noted in the 1978 Assessment (Volume II, p.36). Many of the same deficiencies still exist.

The Contract Team suggests that:

- school districts provide for the incorporation of science and storage rooms in new elementary school buildings and for the conversion of some existing general classrooms into rooms with adequate science facilities

- school districts and principals examine schools for ways to utilize available space so that central storage and preparation space is available for science teaching

6.5.2 Safety Equipment

Question 12 also requested information regarding the adequacy of safety equipment (unspecified) in elementary schools. Twenty-six percent of the teachers felt that such equipment was not required, 32% reported it to be adequate, and 42% reported it to be missing or inadequate. Question 13 asked how systematically such equipment is tested. On this question, 61% of the teachers reported that they had no safety equipment, 19% reported casual checks, and 20% reported systematic checking. All figures show little change since 1978, except that systematic checking seems to have declined from 24% to 20%.

The Contract Team recommends that:

the Ministry of Education establish safety standards for elementary school science classrooms, and provide funds for school districts not only to conduct surveys of the science safety equipment in schools where science is taught but also to correct deficiencies that may be discovered through such surveys.

This recommendation is repeated from the 1978 Assessment.

6.5.3 Science Materials and Equipment

A series of questions addressed the problems of science materials and equipment. Question 14 requested information on the frequency with which changes (apart from minor changes) had to be made in teaching plans because of difficulty in obtaining equipment or materials. The majority of teachers (57%) were able to report that changes for this reason "Seldom" or "Never" occurred. However, 36% of the teachers reported experiencing difficulty with availability of equipment and it is disheartening to note that there were still 97 teachers (seven percent) who seldom planned to use equipment. There has been little change in responses to this question since 1978.

Question 19 asked a similar question regarding the difficulty of obtaining materials/equipment with similar results. Sixty-one percent of teachers report that it is "Not Difficult At All" or "Not Very Difficult" compared to 58% in 1978, and 39% report it to be "Somewhat Difficult" or "Very Difficult" compared to 43% in 1978. Since the current programs have been in effect for several years, it is disappointing that so many teachers are still experiencing difficulty with equipment and materials, although the small improvement since 1978 is noted.

Teachers were asked to rate the quality of materials available to them (Question 15). Table 6.16 shows the ratings for both 1978 and 1982.

Table 6.16: Teachers' Ratings of the Quality of Science Materials/Equipment (Percentages)

Rating	1978	1982
Excellent or Very Good	40	23
Satisfactory	42	49
Unsatisfactory or Very Unsatisfactory	18	29

It can be readily seen that there has been a decline in teacher satisfaction with the quality of materials available to them in the last four years. In 1978, it was noted that teachers using the Materials Based Program rated the quality of equipment higher than did teachers using STEM and Exploring Science. Later in this report, it is noted that there has been a shift away from the use of the Materials Based Program toward the latter two programs in the interval between assessments. In part, this may account for the decline in satisfaction, particularly if systematic efforts have not been made to obtain materials/equipment specifically for STEM or Exploring Science. It is important to note that comments regarding lack of equipment or the poor quality of the equipment were more frequent on the questionnaire than any other category of comments. The Contract Team suggests that schools and school districts systematically examine the quantity and quality of the materials/equipment used in their science programs and make a determined effort to effect improvements where these are necessary.

Information regarding teachers' input into purchasing decisions regarding materials/equipment was elicited (Question 19). About two-thirds of the teachers felt that they had adequate input. A small percentage (three percent) felt that the job was being left to them alone and the remainder wished to have additional input. These results are very similar to those of 1978. When the responses from this question were examined by cross-tabulation with the question about the need to change teaching plans (Question 14), it was found that teachers who have little or no input into choosing materials and equipment have to change plans significantly more often than teachers who have adequate input.

Question 17 asked teachers which individual maintained and accounted for the science materials. Table 6.17 shows responses to this question in 1978 and 1982.

Table 6.17: Responsibility for Materials/Equipment in Elementary Schools, 1978 and 1982 (Percentages)

Person Responsible	1978	1982
Each teacher looks after his/her own	38	20
Each teacher looks after certain materials	5	4
A specially designated teacher	36	46
Paid assistant	3	2
No policy	13	20
Head of Science Department	3	--
Other	2	8

School principals and vice-principals were most frequently mentioned as the "Other" who might have the responsibility.

Question 18 asked teachers to identify the most frequent way in which materials/equipment were obtained. As in 1978, a central source in the school was cited most frequently (44%), with a district central source being chosen by 32% of the teachers. It is a concern to the Contract Team that 21% of the teachers most frequently "Get my own materials/equipment" if this response implies that teachers must collect and order, bit by bit, on an individual basis, the materials needed for an adequate science program. It is not possible to make direct comparisons with the comparable 1978 question since multiple responses were solicited in 1978.

Ready access to materials and equipment is essential if elementary science programs are to function as intended. The above analysis shows that there are still many schools in which convenient procedures have not been established. It is suggested that each school assess the effectiveness of its current policies and procedures regarding purchase, availability, and storage of science equipment and materials.

6.5.4 Print and Audio-Visual Materials, and Micro-Computers

Question 21 sought to assess the adequacy of science reading materials in the school. Table 6.18 is a comparative table for the results in 1978 and 1982.

While about 60% of the teachers still felt that the print materials available to them were satisfactory, there has been a significant decrease in satisfaction with these resources. The shift, discussed later in the report, away from the Materials Based Program toward a more informational approach to science teaching may be causing teachers to place more reliance upon printed sources. In many fields of science, progress has been very rapid and materials are soon out of date.

Table 6.18: Elementary Teachers' Ratings of Adequacy of Science Reading Materials in Schools in 1978 and 1982

Rating	1978*	1982
Very Inadequate	7	11
Somewhat Inadequate	21	31
Satisfactory	53	52
More than Adequate	19	7
There is No School Library	5	--

* Total is greater than 100% due to multiple response

The Contract Team recommends that:

- teachers of elementary school science work with school librarians to explore the possibility of upgrading the quality and quantity of print materials available to students in science.

Both Question 12, in which 78% of the teachers stated that the audio-visual equipment accessible to them was "Adequate" or better, and Question 22 indicate that most teachers have little difficulty obtaining such equipment and materials when needed. This area, which is common across all subject areas, seems well taken care of except in a minority of cases. Further comments on Question 22 are made in section 6.10.1 of this report.

Micro-computers, which have recently begun to appear in elementary schools, have not yet had much impact in the science program. Fewer than four percent of the respondents indicated any use of micro-computers in science classes.

6.6 Science Teaching

The questionnaire asked teachers a series of questions about the emphasis in number of classes and in time which they gave to science teaching, preferences regarding teaching level, feelings of adequacy of preparation for the task, rating of the worth of the current program, and suggestions for general directions for change.

6.6.1 Number of Classes to Which Science is Taught

Question 27 asked teachers to report the number of classes to which they taught science. The data for 1982 are shown in Appendix H.

Nearly 80% of the elementary teachers taught science to only their own class. One teacher in five taught more than one science class. Considering that the 1982 questionnaire went only to those teaching science, the proportion of teachers specializing in elementary science teaching remains comparable with 1978.

The data from this question were tabulated by sex and discussed earlier in Section 6.3.1.

The results of Question 27 were also tabulated against the results of Question 5 (Teachers' Education Background). Table 6.19 shows the relationship between the number of courses in teaching science taken by the number of classes taught.

Table 6.19: Relationship of Number of Science Classes Taught
by Number of Methods Courses Taken (Percentages)

Number of Classes Taught	Number of Methods Courses Taken			
	None (N* = 269)	Less than One (N = 113)	One (N = 653)	2 or more (N = 270)
My class only	80	75	81	69
2 or more classes	20	25	19	31

* N = Number of Teachers

Table 6.20 shows similar data for courses taken in biological sciences.

Table 6.20: Relationship of Number of Science Classes Taught
by Number of Biology Courses Taken (Percentages)

Number of Classes Taught	Number of Methods Courses Taken			
	None (N* = 655)	Less than One (N = 34)	One (N = 368)	2 or more (N = 254)
My class only	82	62	80	65
2 or more classes	18	38	19	35

* N = Number of Teachers

Tables for the number of classes taught by the number of courses taken in earth/space/general science and in physical science show a similar pattern to the biological sciences table above.

These tables show little difference in the teaching assignments of elementary teachers with no education in science methodology or no science background and the assignment of teachers with the basic background of a single course. In the Contract Team's opinion these tables show that teachers with better than average backgrounds in methodology or in the basic sciences are being under-utilized in terms of their training. Of teachers with two or more courses in science methodology, 69% teach only their own class. For biological sciences, the figure is 65%; for earth/space/general science, it is 61%; and for physical science, it is 59%.

The Contract Team urges school administrators to ascertain the science backgrounds of their staffs and, when possible seek to utilize teachers with good science and science education backgrounds to a greater extent as science teaching specialists and as resource people for the school staff.

6.6.2 Time Spent in Teaching Science

Teachers reported the amount of time spent teaching science each week (Question 26). The data shown in Appendix H include all elementary teachers, primary as well as intermediate, those who teach more than one class, as well as those who teach only their own class. Table 6.21 shows the percentages of teachers who teach only their own class and reports the various times spent teaching science each week.

As expected, the average intermediate teacher devotes more time to science teaching than does the average primary teacher. When these times are compared to the Ministry of Education recommendations for time allotments for science, it is seen that many teachers are not giving science instruction the emphasis it should be receiving. The times recommended for social studies and science combined for Grades 1, 2, and 3 are 120 minutes, 120 minutes, and 135 minutes respectively, but 22% of the primary teachers are giving science 30 minutes or less per week. The times recommended for science in Grades 4-7 are 90 minutes for Grade 4, 135 minutes for each of Grades 5 and 6 and 170 minutes for Grade 7. Two-thirds of the intermediate teachers are spending less than 90 minutes per week in science. The disappointing results in pupil achievement may be a reflection of this under-emphasis in time.

Table 6.21: Time Per Week Spent in Science Teaching by Elementary Teachers Who Teach Only Their Own Class

Time (minutes)	Percent of Teachers	
	Primary	Intermediate
1-30	22	2
31-60	52	21
61-90	21	42
91-180	5	34
181-300	-	1
Number of Teachers	512	489

The Contract Team is seriously concerned about the time spent in teaching science and strongly recommends that:

- school administrators and teachers follow the time allocations given for science instruction in the Administrative Handbook.

Aside from the level at which one teaches, a number of factors might be related to the amount of time a teacher spends in science teaching. A number of these factors will appear in subsequent sections of this chapter. One such factor examined was the teachers' educational background as reported in Question 5. Table 6.22 shows the average time spent in science teaching per week by teachers with differing biological science backgrounds.

It is evident that a significantly higher proportion of the teachers with two or more biology courses spend more time in teaching science than their colleagues with less biology background. A similar relationship exists with respect to general science background. The same pattern pertains weakly for courses in science teaching methods, and a much stronger relationship is shown for courses in physical science. These considerations reinforce the suggestion of 6.6.1 that there be better utilization of those with good science backgrounds.

Table 6.22: Average Time Spent Per Week in Teaching Science by Teachers With Differing Biological Science Backgrounds (Percentages)

Time	Number of 3-Unit Courses in Biology		
	None or Less Than One (N = 684)	One (N = 368)	2 or more (N = 252)
1-60 min.	46	39	24
61-90 min.	26	29	22
more than 91 min.	28	32	54

6.6.3 Satisfaction in Teaching Science

Teachers were asked at which grade level they preferred to teach science (Question 24) and the data are shown in Appendix H. It is worthwhile noting that one teacher in nine presently teaching science would prefer not to teach science. Only a small percentage of elementary teachers would prefer to teach science at secondary or higher levels.

Table 6.23: Preferred Science Teaching Placements of Elementary Teachers (Percentages)

Preferred Placement	Current Placement	
	Primary	Intermediate
Not Teach Science	11	11
Kindergarten/Primary	75	4
Intermediate	13	80
Post Elementary School	1	5
	(N = 579)	(N = 729)

Table 6.23 shows the teaching preferences of present elementary teachers. A small percentage (four percent) of intermediate teachers would prefer primary and a somewhat larger percentage (13%) of primary teachers would prefer intermediate grades. However, the preponderance of elementary school teachers seem comfortable with their current placement.

Question 25 asked teachers how adequately prepared they felt to teach science. It was the intention of the questionnaire developers that teachers would answer this question on the basis of their current feelings of confidence, based not only upon their initial training, but also upon the total set of experiences gathered since that time. In this, the question differed from Question 31. Question 25 replaced the 1978 question asking teachers "As a rule, are you comfortable teaching science?" The data in Appendix H show that, while 58% of the teachers feel adequate or better, 37% are somewhat doubtful of their adequacy and five percent feel inadequate.

Perceived adequacy was tabulated against the number of courses taken in teaching science (Question 5.1). The results appear in Table 6.24.

Table 6.24: Ratings of Teachers' Perceived Adequacy by Methods Courses Taken

Perceived Adequacy	Number of Methods Courses Taken			
	None or Omitted	Less than One	One	2 or more
Not at all	11	7	4	2
Somewhat	43	40	41	20
Adequately	37	41	47	53
More than Adequately	9 (N = 265)	12 (N = 113)	8 (N = 656)	26 (N = 270)

As we would expect, increased training in methodology increases feelings of adequacy for most but a surprisingly large percentage (46%) of those untrained in science teaching feel "Adequate", and 22% of those with two or more courses still feel less than "Adequate".

Similar tables were examined comparing the number of biological, physical, or earth/space/general science course backgrounds with teachers' perceived adequacy, and the results were similar. Approximately 50% of those with no background in each area felt adequate or better, while over 80% of those with two or more courses felt at least adequately prepared.

Cross-tabulation with Question 26 showed that teachers who perceive themselves as adequately prepared are much more likely to spend larger amounts of time on science teaching than those who feel inadequate. Similarly, comparison with Question 27 shows that, of teachers who feel adequately prepared or better, 30% are teaching more than one science class compared to 12% of those who feel inadequately prepared.

Table 6.22 in the preceding section shows that, regardless of feelings of adequacy, teachers with weak science education backgrounds spend less time teaching science.

6.6.4 Worth of the B.C. Science Program

Commitment to teaching a program and effort expended upon it are likely to be closely related to the value seen in the program. Question 23 asked teachers to rate the worth of the prescribed program in British Columbia.

The preponderance of teachers (88%) see value in the present program, but it is disappointing that only one in four gives it the highest rating. The ratings given, while similar to those of junior secondary school teachers, fall well below those of senior secondary teachers (Section 7.6.1). In the 1978 Assessment, the Contract Team felt that this question was premature because of the curriculum change just completed then. However, there has been little change in the worth teachers ascribe to the program as they have become familiar with it. Sub-populations of teachers were examined to see if variations existed in their ratings for the worth of the program. No significant differences were found when males were compared to females, when teachers of differing lengths of experience were compared and when teachers were compared on the basis of the programs with which they were most familiar. Intermediate teachers were slightly more positive in their ratings than primary teachers. Of the variables examined, only teachers' feelings of their present adequacy of preparation for teaching science showed a strong relationship to the rating of worth, with those feeling "Adequately" or "More than Adequately" prepared rating the program more favourably. This analysis is shown in Table 6.25.

Table 6.25: Teacher Ratings of Worth of the Science Program by Reported Feelings of Adequacy of Preparation (Percentages)

	Feeling of Adequacy of Preparation			
Worth	Not at all	Somewhat	Adequately	More than Adequately
Very Worthwhile	10	13	29	39
Some Worth	75	72	61	46
Little Worth or Worthless	15	15	9	14

6.6.5 Teachers' Suggestions for Change

In Question 28, teachers were asked to indicate whether they would like "Less", the "Same", or "More" of each of a list of items in their school's science program. This list is rank-ordered by medians in Table 6.26 on a scale of three (more) to one (less). Rankings for the similar but shorter list from 1978 are also shown.

For the first 10 items on the list, more than 50% of the province's elementary teachers would like a greater emphasis. More than 10% of the teachers felt less emphasis was required for only items ranked 20 and 21, the items about assessments, and for these items two out of three teachers felt the present provision was desirable. Teachers' expressed attitudes to these assessment items and to Item 19 (definition of core curriculum) are far less negative than they were on Question 37 of the 1978 questionnaire.

Table 6.26: Teachers' Suggestions for Changes in the School's Science Program (Ranked by Medians)

1978 Rank	1982 Rank	Number of Question	Suggested Change	1982 Median**
2	1	(1)	*Provision of print materials other than textbooks	2.83
1	2	(11)	Background information for teachers	2.80
--	3	(18)	Provisions for meeting needs of gifted children	2.75
7	4.5	(4)	Activity-centred learning	2.61
--	4.5	(20)	Specialist science teachers in elementary schools	2.61
4	6	(6)	Locally developed programs	2.59
3	7	(16)	Environmental education	2.54
6	8.5	(2)	Integration of science with other subject areas	2.53
8	8.5	(3)	Discovery learning	2.53
--	10	(17)	Field trips	2.51
10	11	(5)	Alternate programs in science	2.49
5	12	(7)	Outdoor education	2.46
--	13	(19)	Provisions for meeting needs for handicapped children	2.42
--	14	(21)	Emphasis on the impact of science on society	2.41
11	15.5	(8)	Teaching of basic science concepts	2.29
9	15.5	(15)	Teacher input into purchase of equipment	2.29
12	17	(9)	Teaching of science processes	2.27
13	18	(14)	Freedom of teacher to define course	2.19
14	19	(10)	Definition of core curriculum	2.18
15	20	(13)	District Learning Assessment	2.01
16	21	(12)	Provincial Learning Assessment	1.91

* This item was "Provision of materials other than textbooks" on the 1978 questionnaire.

** Scale is from 1 (less) to 3 (more).

It is evident that teachers feel the need for scientific information to be presented both for pupils and for themselves in forms which can be readily understood. There is a need for emphasis on programs or materials for gifted children and a call for increasing materials and activities that relate to pupils' immediate environments (environmental education, field trips, locally developed programs).

Fifty-six percent of the elementary teachers suggested that more specialist science teachers in elementary schools would improve school programs. Sixty-one percent of the secondary teachers concurred with this opinion. Activity-centred learning, discovery learning, and subject integration are still perceived by teachers to be desirable but not fully achieved.

These considerations reinforce the suggestions regarding science specialists and school library materials made earlier in Section 6.6.1 and 6.5.4.

The Contract Team urges school districts to provide more programs for meeting the needs of gifted children. The Contract Team recommends that:

- the Program Implementation Branch of the Ministry of Education coordinate the design, development and delivery of in-service programs for elementary teachers

6.7 Teacher Education

Teachers were asked to evaluate their pre-service and in-service educational experiences as preparation for elementary school science teaching.

6.7.1 Pre-Service Education

Question 31 requested a rating of the adequacy of the pre-service teacher education programs in terms of preparation for teaching elementary school science. The results show that fewer teachers (26%) felt their program was "Very Inadequate" than in 1978 (35%). It is a matter of concern that only 30% of the teachers felt their pre-service training to have been "Adequate" or better. The percentage of secondary teachers expressing satisfaction (48%) was significantly greater than elementary teachers.

Table 6.27 compares the teachers' ratings of their pre-service education with their current feelings of preparedness for teaching science (Question 25).

Table 6.27: Teachers' Ratings of the Adequacy of Pre-Service Training by Feelings of Preparedness for Teaching of Science (Percentages)

Current Feelings of Preparedness	Rating of Pre-service Training: Very Inadequate	Somewhat Inadequate	Adequate or More
Not at all	17	2	0
Somewhat	48	44	17
Adequately	28	45	60
More than Adequately	6 (N* = 330)	9 (N = 570)	23 (N = 388)

* N = number of teachers

This table shows a strong relationship between the ratings of adequacy of initial preparation and current feelings of preparedness.

The Contract Team recommends that:

- any Faculties of Education require all pre-service elementary teachers to take a course in science teaching methodology.

This recommendation is important in light of the effect such preparation would likely have on many teachers' feelings of competence and their subsequent science teaching behaviors in the classroom throughout their careers.

Questions 29 and 30 asked teachers to respond to two identical lists of teacher education components. The first list asked the degree of emphasis each component SHOULD have in preparing a person to teach science. The second list asked teachers to state the emphasis which WAS placed on this component in their teacher education program. The rating scale has been coded from one (very little emphasis) to four (very heavy emphasis) and the items are arranged in Table 6.28 according to the median rating for the emphasis which SHOULD be received. The emphasis which WAS received is noted in an adjacent column.

Examination of this table shows that, for each component listed, teachers felt that it should receive greater emphasis than it did receive, and for 16 of the 23 items the mismatch was greater than one point on the scale. These discrepancies present problems to those who have responsibility for planning teacher education programs, given time constraints. The first five components and the eighth component on the list are broad general elements which usually form part of teacher preparation. However, it is evident that practising teachers feel the need for increased emphasis even in these areas. This is particularly true of the development of curriculum materials and discussion of problems in science teaching. Components ranked six and seven relate to the content background of teachers, and the expressed mismatch here was less than that in other general

Table 6.28: Emphasis that SHOULD be and Emphasis that WAS Placed on Teacher Education Components (Rank by Emphasis Component Should Receive)

Rank of Emphasis Component SHOULD Receive	Number of Question	Component	Median*	
			SHOULD	WAS
1	(15)	Practice in Teaching Science	3.65	2.22
2	(13)	Lesson Planning	3.44	2.81
3	(1)	Techniques of Teaching Science	3.41	2.19
4	(12)	How to Develop Curriculum Materials	3.36	1.90
5	(14)	Preparation of Science Materials	3.34	2.12
6	(5)	General Science	3.14	2.42
7	(4)	Subject Matter in Specific Areas of Science	3.05	2.16
9	(16)	Discussion of Problems of Science Teaching	3.01	1.47
9	(19)	Laboratory Safety	3.01	1.32
9	(22)	Use of Community Resources	3.01	1.45
11.5	(11)	Survey of Available Curriculum Materials	2.98	1.76
11.5	(23)	Use of Audio-Visual Materials	2.98	1.88
13	(21)	Integration With Other Subjects	2.92	1.68
14	(2)	Techniques for Developing Reading Skills in Science	2.84	1.25
15	(3)	Technique for Developing Writing Skills in Science	2.76	1.23
16	(8)	Testing/Evaluating/Grading in Science	2.74	1.71
17	(18)	Care and Maintenance of Equipment	2.55	1.30
18	(17)	Care and Observation of Animals in the Classroom	2.39	1.15
19	(7)	Psychology of Learning	2.30	1.77
20	(9)	Child Psychology	2.27	1.69
21	(20)	Special Education	2.25	1.11
22	(10)	Theories of Intellectual Development	2.07	1.48
23	(6)	History and Philosophy of Science	1.79	1.20

* Scale from 1 (Very Little Emphasis) to 4 (Very Heavy Emphasis)

categories. Components ranked 9-18 are much more specific topics than components ranked 1-5 and several of these would be discussed only in a science methods course in a teacher education program. Although they are considered to be of lower priority, the mismatch between "WAS" and "SHOULD" was quite high for several of these items. Attention is called to "Laboratory Safety", "Reading and Writing in Science", and "Use of Community Resources". Considering the time that elementary teacher education programs typically devote to Language Arts instruction, it is surprising that teachers felt that there was a need for specific instruction in techniques for developing skills in reading and writing in the subject area of science.

When the data from elementary teachers were compared with that for secondary teachers shown in Table 7.17, the major difference was the greater emphases elementary teachers placed on need for instruction in curriculum development, subject integration, and use of community resources.

When the data for Question 29 were compared with the data from the similar but shorter question on the 1978 questionnaire the responses were very similar. Teachers are showing great stability in the components of teacher education program which they value.

Because of the teachers' response to the whole of this section of the questionnaire just discussed, the Contract Team recommends that:

- Faculties of Education in British Columbia should give greater emphasis to each of the techniques and topics identified by teachers to be most inadequately emphasized in their pre-service training.

6.7.2 In-Service Education

Question 32 asked teachers to indicate the amount of in-service education they felt was required "THIS YEAR" to do a good job teaching science. Table 6.29 shows the responses by level of teaching for 1978 and 1982. This table shows that, while nearly 50% of the teachers in 1982 felt the need for quite extensive in-service work, there were more teachers than in 1978 who did not feel the need for in-service training.

Table 6.29: In-Service Education Needed by Primary and Intermediate Teachers' 1978 and 1982 (Percentages)

In-Service Needed	Primary		Intermediate	
	1978	1982	1978	1982
None	11	17	15	23
One Workshop	44	34	35	31
Several Workshops	34	38	39	36
Refresher Course	10	10	9	11

Expression of a need does not necessarily imply a willingness to do anything about it. Questions 35 and 36 addressed this issue. The data are in Appendix H. Workshops in release time can count on extremely high participation. Workshops in the teachers' own time after school would be well attended but weekend workshops do not appear to have a high chance of success, although there are some teachers who would attend.

In-service needs were analyzed in terms of Current Feelings of Preparedness for Teaching Science (Question 25).

Table 6.30: Current In-Service Education Needs by Current Feeling of Preparedness for Teaching Science (Percentages)

Current In-Service Needs	Current Preparedness for Teaching Science			
	Not at all	Somewhat	Adequately	More than Adequately
None	0	8	25	47
One Workshop	15	27	40	29
Several Workshops	46	50	30	19
Refresher Course	39 (N* = 66)	15 (N = 472)	5 (N = 582)	6 (N = 158)

* N = number of teachers

This table demonstrates that strong relationships exist between teachers' perceived weaknesses and their recognition of in-service needs. Most of those who feel inadequately prepared recognize that a substantial time commitment, (several workshops or a refresher course), is needed to increase their confidence in their ability to teach science well. Substantial percentages, 35% of those who feel "Adequately" prepared and 25% of those who feel "More than Adequately" prepared still feel the need for extensive in-service.

Question 33 attempted to determine the forms of in-service education which teachers have experienced and which they value. The data are shown in Appendix H. Table 6.31 ranks the in-service methods in order of value on a scale of one (little value) to three (much value). Those who have "Not Experienced" a particular form were excluded from the calculation of median and percentage values.

Table 6.31: In-Service Methods Ranked by Median Value of Elementary Teachers' Ratings

Rank	Number of Question	In-Service Method	Median Value	Percent of Those Who Have Experienced			Percent Who Have Not Experienced
				Little Value	Moderate Value	Much Value	
1	(4)	Workshops presented by other teachers	2.30	7	54	38	16
2	(6)	Workshops presented by district personnel	2.26	9	54	36	30
3	(11)	Visits to other classrooms	2.23	12	52	36	32
4	(1)	Informal meetings with other teachers	2.21	13	52	35	28
5	(12)	Annual conferences for science teachers	2.15	18	49	33	71
6	(9)	University credit courses in science content	1.96	26	52	23	29
7	(5)	Workshops presented by university science educators	1.95	25	55	19	45
8	(10)	University credit courses in science methods	1.90	29	53	17	30
9	(7)	Workshops presented by scientists	1.80	37	44	19	79
10	(3)	Informal meetings with scientists	1.70	42	41	17	78
11	(2)	Informal meetings with university science educators	1.66	43	45	12	61
12	(8)	Workshops presented by Ministry of Education officials	1.53	49	40	11	85

The table reveals that, in general, the most familiar forms of in-service education are the most valued. These are also the least expensive and easiest to arrange. Teachers most appreciate the help which they obtain from their peers and close associates, such as district personnel. It is therefore disappointing that a substantial number of teachers have not experienced visits to other classrooms or informal meetings with other teachers. The results on this question are very similar to those on the nearly parallel question asked in 1978.

University science educators do not seem to be reaching elementary teachers as extensively as perhaps they might think, with only a little over half the teachers having experienced workshops conducted by such individuals, and fewer than half having interacted informally with them. The community of scientists is touching the elementary school teaching force only slightly. Since many Ministry of Education personnel are teachers seconded for short appointments, it is difficult to know whether or not teachers identified workshops conducted by such people as "Ministry" workshops separately from those conducted by "other teachers".

The Contract Team urges university science educators to re-examine the extent of their field contact as well as the forms of presentations which they provide. Since all future scientists attend elementary schools, university, industrial, and government scientists are urged to seek contacts with elementary schools and teachers. Furthermore, school districts and teachers should consider ways to involve themselves with the practising scientists and scientifically trained people in their areas.

The results of teachers' ratings of the in-service activities in their district appear in Table 6.32.

Table 6.32: Teachers' Ratings of the Effectiveness of Science Education In-Service Activities Provided in the School or District

Effectiveness of In-Service	Percent of Teachers	
	1978	1982
No In-service in science	25	33
Very Ineffective	13	6
Somewhat Ineffective	27	19
Fairly Effective	32	36
Very Effective	3	6

Two changes are evident since 1978. There has been a substantial increase in the percentage of teachers reporting the lack of a science in-service program. The decline of in-service opportunities may be partly due to the fact that the elementary science program was quite new in 1978 but has now been established for several years. Those experiencing in-service are expressing increased satisfaction with it, 35% giving "Fairly Effective" or "Very Effective" ratings in 1978, 42% in 1982. It is disappointing, however, to note such a small percentage (six percent in 1982) rating the in-service as "Very Effective".

In terms of the expressed and demonstrated need for in-service, and of the expressed willingness of teachers to participate in such activities, it is discouraging to note that one teacher in three reports that there is no local opportunity for science-related in-service. Cross-tabulation showed that teachers with little experience are more likely to teach in districts with no in-service program than are teachers with more experience. Fifty percent of teachers with one to two years experience and 43% of teachers with three to five years experience were in such districts compared to 26 percent of teachers with more than 15 years experience. Teachers' ratings of in-service effectiveness are unrelated to the expressed level of in-service need. Table 6.33 shows the effectiveness ratings by teachers in terms of their current feelings of adequacy (Question 25). These data indicate that teachers who feel ill prepared have less access to in-service education than others. Teachers who are confident of themselves tend to rate the in-service program more highly than those less sure of themselves.

Table 6.33: Teachers' Ratings of Effectiveness of District In-Service by Feelings of their Current Preparedness for Teaching Science (Percentages)

Effectiveness of In-Service	Preparedness for Teaching Science			
	Not At All	Somewhat	Adequately	More than Adequately
No in-service	39	35	31	32
Very ineffective	11	8	5	6
Somewhat ineffective	20	22	18	11
Fairly effective	27	32	38	40
Very effective	3	4	7	12
	(N* = 64)	(N = 464)	(N = 570)	(N = 152)

* N = Number of Teachers

It is probable that school or district in-service programs are planned by teachers and supervisors with strong science backgrounds and with confidence in themselves as science teachers. It may be that they do not perceive the in-service needs of teachers in quite the same way as do those who have weaker backgrounds and who have less self-assurance in the science area. These data suggest that the weaker background teachers should be involved in the planning of in-service work.

This section of the report has pointed out the need for far more extensive in-service opportunities in science for elementary teachers. However, the time pressures under which elementary teachers work must be kept in mind. This implies that release time for in-service is desirable.

> The Contract Team urges school districts to make an effort to foster and provide more science in-service education for elementary school teachers

This suggestion might be implemented with emphasis on informal meetings of teachers, workshops conducted by teachers and visits to other classrooms. This is a reiteration of a 1978 Science Assessment recommendation.

6.8 Assessment and Testing

Two questions were asked about the 1978 Science Assessment and its impact.

The first of these, Question 37, indicated that only a small proportion of elementary school teachers had read the Assessment reports. Nineteen percent had read the Summary Report, 15% had read their district's Interpretation Report and only five percent had read either volume of the General Report. The Contract Team finds the above disappointing since there are many insights and recommendations in these reports which are relevant to elementary science teaching.

The next question dealt with the teachers' perception of the impact of the 1978 Assessment on nine factors relevant to science teaching. On these factors, between 63% and 87% indicated either that the asessment had no impact or that they did not know. Some teachers (16%) saw a significant change in curriculum emphasis and 12% saw a significant change in provision of supplementary materials. Only nine percent reported "Significant" changes in their own teaching.

The Contract Team urges districts to make the various reports that evolve from the Assessment, including the district's Interpretation Report, available to all elementary teachers in the district.

6.9 Elementary Science Program

Determining the extent to which teachers use the curricular materials accessible to them, identifying the reasons for their choices among options, and noting their preferences are important facets of an assessment. Eleven questions asked teachers about the curricular facets of their science program.

6.9.1 The Programs in Use

Table 6.34 reports the results for Question 43 which was designed to determine teachers' access to printed materials for the three alternative prescribed programs in British Columbia.

Table 6.34: Teachers Reporting Availability of Printed Materials (Percentages)

Materials	1978*	1982
Materials-Based Program	51	44
STEM	77	86
Exploring Science	74	89
None of These	4	2
I don't know	4	1

* The corresponding question was worded slightly differently in 1978 from 1982.

At present, the two textbook series (STEM and Exploring Science) are available to a great majority of the teachers and they are much more accessible now than they were in 1978. The Materials-Based Program has declined in availability to the point where fewer than half of the teachers now have access to it. It is important to note that no differences were found in the accessibility of these materials when examined in terms of school size.

Table 6.35 shows teachers' responses by grade level to the question, "Do you actually USE one program or a combination?"

Table 6.35: Program Combinations Used* by Grade Level (Percentages)

Program Combination Used	Grade 1	2	3	4	5	6	7	Percent of Total
One program	0	1	2	7	9	4	10	5
One program supplemented by own ideas	14	18	21	22	22	22	29	21
A combination of programs	12	13	12	16	19	19	13	14
A combination of programs supplemented by own ideas	74	68	65	56	51	55	49	59
N** =	(202)	(187)	(203)	(167)	(178)	(175)	(206)	

* Teachers choosing locally developed programs are not shown on this table.
** N = Number of Teachers

The table shows that nearly three-fourths of the teachers are using a variety of materials in their teaching. The proportion doing so has increased since 1978 when 67% stated they used a combination of programs. The above table shows that primary teachers are more likely to use a variety of programs than are intermediate teachers and that Grade 7 teachers are most likely to use a single program, either as provided or with their own supplements.

Teachers stated the extent of their use of available curriculum materials (Question 47). The data in Appendix H are adjusted percentages ignoring missing data. On this question, many teachers omitted responses which probably means that they did not use the materials indicated. Table 6.36 gives the actual percentages of the total sample of 1,322 teachers who indicated particular frequencies of use.

Table 6.36: Reported Frequencies of Curriculum Material Use (Percentages)

	Percentage of Time Materials Actually Used					
Materials	0%	1-5%	6-25%	26-50%	51-100%	No Response
STEM Texts	15	15	25	18	6	20
Exploring Science Texts	11	11	22	22	20	15
Materials Based Units	13	10	19	11	4	43
Materials Based Program Interim Guide	25	7	6	2	1	57
Elementary Science Interim Guide	20	11	7	2	2	57
Locally Developed Units	16	9	17	7	4	47
Teacher Developed Units	6	8	25	21	16	25
B.C.T.F. Lesson Aids	20	16	[illegible]	2	1	50

This table shows that the Exploring Science series is the most frequently used set of materials in the schools. STEM texts are used less frequently and the Materials-Based units even less. The curriculum guides seem to be used little by most teachers. The frequent use of units developed by the teachers themselves is noted and commended.

When the results of this question were compared to those of the similar question from the 1978 Assessment, a trend toward increased use of the two textbook series was seen. Since the Exploring Science series suggests fewer activities for pupils than the other options, these data may partially explain the pupils' performance weaknesses on some questions in the Science Processes domain of the achievement surveys.

The Contract Team urges teachers to make extensive and serious use of the new Elementary Science Curriculum Guide Grades, 1-7 (1981).

6.9.2 Supplementing the Program

Question 52 requested teachers to supply information about their chosen ways of supplementing the science program, and the data, along with those from a similar 1978 question, are in Table 6.37.

Table 6.37: How the Elementary Science Program is Supplemented* (Percentages)

Method of Supplementing	1978	1982
No opportunity/time to supplement**	6	9
No need to supplement	8	3
Additional/extra reading	34	32
Additional/extra content	41	46
Additional/extra activities	76	81
Additional/extra equipment	24	38
Integration with other subjects	-	61

* Columns sum to > 100% due to multiple responses
** When 1978 wording differed from 1982 it is shown as 1982/1978 wording.

Most teachers expressed a need to supplement a basic program, and this need has grown since 1978. Overwhelmingly, the preferred method is to provide pupils with additional activities. Unfortunately, the questionnaire did not request information as to the style of these activities, but the increased use of supplementing by providing additional equipment suggests that many of these activities are of a hands-on, investigative nature, and, where this is so, it is to be encouraged. The slight decline in the use of extra reading may be a reflection of the quality and quantity of library print materials discussed earlier.

It was thought that teachers with differing amounts of experience might handle the matter of supplementing a program in different ways. Therefore, bivariate distributions were prepared comparing responses on this question with teaching experience. For only one method were significant systematic differences found, and that was the most popular. Long-experience teachers stated they used additional activities less than did short-experience teachers--75% of teachers with more than 15 years experience compared to 88% of teachers with one to two years experience.

6.9.3 Materials for Teaching the Program

Question 53 requested information about the sufficiency of materials for teaching the program selected and Table 6.38 shows comparative results with 1978.

Table 6.38: Teachers' Ratings of the Sufficiency of Materials (Percentages)

Sufficiency of Materials	1978	1982
Sufficient Materials	49	57
Insufficient Materials	44	39
No Materials	3	1
I don't know	3	2

The changes between 1978 and 1982 indicate either a substantial increase in the materials available or a movement toward a program which requires fewer materials. Evidence elsewhere in this report indicates that the second possibility must be considered as a partial explanation for the noted change. However, it is of serious concern that 40% of the teachers are still reporting insufficient or no materials, and therefore these data reinforce the recommendation in Section 6.5.3.

The responses to this question were examined by cross-tabulation with some of the related questions discussed in Section 6.5.3. Most of the teachers (75%) who reported sufficient materials also reported on Question 14 that they seldom or never have to change plans because of lack of equipment, while 60% of those who reported insufficient materials also reported frequent plan changes. Eighty-nine percent of teachers who reported sufficient equipment reported its quality to be "satisfactory" or better on Question 15, while only 41% of those who have insufficient materials rated the quality of materials they do have that highly. A strong relationship also exists between the ratings of sufficiency and the teachers' influence upon the purchase of materials/equipment. These data suggest that, in the re-examination of equipment and materials suggested earlier, there should be co-operative involvement of all those teaching science.

6.9.4 The Choice of the Program in Use

Questions 45 and 46 related to the locus of, and reasons for, the choice of the current program in the school. Forty-four percent of the teachers attributed all or part of the choice to classroom teachers and the majority of those who selected the "Other (specify)" option attributed the choice to teachers, often themselves. District supervisory personnel and advisory groups seem to have had major input into the decisions, but school principals were perceived as significant decision makers in only a small proportion of the cases.

Cross-tabulation of Question 45 with Question 10 (Form of District Science Coordination) revealed no discernable patterns of decision making related to district level coordination. Cross-tabulation with Question 44 showed no relationship between the locus of choice and the program chosen. Such patterns and relationships might have been expected.

Question 46 sought to locate the factors influencing the program chosen. Predictably, the most important factor was "the program was thought to promote the best approach to science teaching". Usability and availability were also frequent choices. Economy was not thought to be a major factor by many of the teachers. Teachers also listed a wide variety of additional reasons, not easily classifiable, for choosing their current program. It is of concern that 29% of the teachers do not know why their current program is in use and 15% are unaware of how it was chosen. These percentages are smaller than those reported in 1978 but large enough to indicate a lack of communication within districts.

6.9.5 Teachers' Evaluation of Program Characteristics

A series of questions sought to determine teachers' opinions of characteristics of the three alternative programs by asking teachers to indicate the program with which they were most familiar and the program which they preferred. Data for Questions 48 and 50 are shown in Table 6.39.

Table 6.39: Teachers' Ratings of Familiarity with, and Preference for, Program Alternatives (Percentages)

Program	Most Familiar Program		Program Preferred	
	1978	1982	1978	1982
Materials Based Program	31	14	24	27
STEM	31	33	24	30
Exploring Science	31	48	31	43
None/I don't know	1	6	21	-

Almost half of the teachers have greater familiarity with Exploring Science than with the other programs. The proportion having greatest familiarity with the Materials Based Program has declined markedly in the last four years. This decline is another indication of the trend away from the hands-on, materials-based approach to science teaching. However, there are a substantial number of teachers who prefer the Materials Based Program, though preferences for Exploring Science and STEM are even greater.

Cross-tabulation data between Questions 48 and 50 are shown in Table 6.40. Responses to "None of These" in question 48 are omitted. This table shows that most teachers prefer the program that they know best, with this tendency strongest for the Materials Based Program. It is important to note that a substantial number of those most familiar with STEM or Exploring Science prefer the Materials Based approach.

Table 6.40: Prefered Program by Most Familiar Program (Percentages)

Preferred Program	Most Familiar Program		
	Materials Based	STEM	Exploring Science
Materials Based	89	18	15
STEM	5	75	5
Exploring Science	6	7	80
	(N* = 151)	(N = 359)	(N = 511)

* N = number of teachers

In Question 49, teachers rated the attributes of the program with which they were most familiar. The data are shown by program in Appendix H. Table 6.41 shows mean ratings by program on a scale of one (Poor) to five (Excellent) for these attributes.

Table 6.41: Teachers' Ratings of Program Attributes*

Attribute	Mean Rating of Attribute**					
	Materials Based		STEM		Exploring Science	
	1978	1982	1978	1982	1978	1982
Availability of Materials	3.0	3.1	2.7	2.8	2.9	2.9
Readability of Texts	2.9	2.8	3.5	3.1	3.6	3.2
Relevance to Students	3.4	3.6	3.5	3.1	3.5	3.2
Ease of Teaching	3.0	3.3	3.4	3.1	3.6	3.3
Ease of Preparation	2.8	2.9	3.2	3.0	3.4	3.2
Usefulness of Teacher's Guide	3.1	3.2	3.6	3.3	3.4	3.2
Balance Between Content and Process	3.0	3.3	3.4	3.0	3.3	2.9
Amount of Student Activity	4.0	3.9	3.5	3.0	3.2	2.8
Degree of Structure	3.0	3.2	3.3	3.1	3.4	3.2
Suitability to Teacher's Background	3.3	3.5	3.5	3.2	3.5	3.3
Selection of Content	3.1	3.3	3.4	3.1	3.5	3.2
Interest of Students	3.7	3.8	3.6	3.1	3.6	3.2
Overall Rating	3.3	3.5	3.5	3.1	3.6	3.2

* Note that teachers only rated the program with which they were most familiar
** Scale is from 1 (Poor) to 5 (Excellent)

Teachers most familiar with the Materials Based Program gave it high ratings. Almost 50 percent of these teachers rated it as "More Than Satisfactory" or "Excellent". They were especially pleased with its interest and relevance to pupils and with the amount of pupils' activity. They also felt that it was easy to teach, that it was suitable to the teacher's background, and that the content was well selected. Difficulty of preparation was the chief concern and 24% of the teachers also had concerns regarding the availability of materials. The readability of texts, which shows as a concern in the table in Appendix H, is an item of little relevance to this program.

Teachers most familiar with the STEM program rated far fewer attributes as highly as the above teachers rated the Materials Based Program. The bulk of responses fell in the "Satisfactory" column. Greatest satisfaction with this program lay in the usefulness of the teacher's guide, its interest for pupils, and its suitability to the teacher's background. There was some concern about the availability of materials. This program makes extensive use of everyday items found in schools, homes, or local stores. It may be that obtaining these items places an additional strain on teachers that they do not feel when kits of materials can be ordered or standard science equipment/materials obtained from a single source. Teacher opinion was divided on the amount of pupil activity the program provides (21% rate it above "Satisfactory", 24% below "Satisfactory").

The Exploring Science program was perceived to be stronger than the STEM program by those most familiar with it. Factors such as ease of teaching, ease of preparation, usefulness of the teacher's guide, suitability to the teacher's background, and readability of the texts rated highly. As always, availability of materials was a concern for some teachers. The other weaknesses teachers saw in this program were that the amount of pupil activity is less than "Satisfactory" (34%) and that the balance of process and content is not appropriate (22%).

It is interesting to note that the ratings given to the Materials Based Program in 1982 exceeded those given in 1978 in all but two cases and that the 1982 ratings for STEM and Exploring Science fell below those for 1978 in all but one case. The differences often indicate a substantial decline in ratings.

Table 6.42 shows the responses given by teachers for preferring a particular program (Question 51). Because of the strong relationship between program familiarity and program preference, one would expect a relationship between the results in this table and those in the preceeding one.

Table 6.42: Teachers' Reasons For Program Preference by Program Preferred (Percentages)*

Reason	Program		
	Materials Based (N** = 293)	STEM (N = 317)	Exploring Science (N = 462)
Materials Readily Available	49	58	60
More Readable	13	52	66
More Relevant to Pupils	82	54	53
Easier to Teach	39	60	71
Easier to Prepare	29	54	67
Better Teacher's Guide	15	56	40
Better Content/Process Balance	64	42	37
Right Amount of Activity	84	48	41
Right Degree of Structure	37	39	48
Suited to My Background	54	56	63

* Columns may sum to > 100% due to multiple response
** N = Number of Teachers

Teachers preferring the Materials Based Program cited its activity orientation and relevance to pupils as reasons for choice far more frequently than any other choices that are indicated on the table. The content/process balance was also a strong reason for choice. Readability as a factor can be discounted as irrelevant in this program. Few teachers would elect this program on the basis of its teachers' guides, and ease of preparation is selected by a minority as a reason for choice.

Teachers who preferred STEM did so for a wide variety of reasons, no single one or cluster predominating. The degree of structure of the program and process/content balance were the least often cited bases for choice.

Those who prefer Exploring Science, most frequently gave as reasons the cluster of factors noted in the preceding discussion of this program with the exception that the teacher's guide was not a strong reason for program choice. The process/content balance and the amount of activity for pupils were also among the weakest reasons.

The picture which has emerged from this section of the questionnaire is that most teachers are utilizing some combination of programs in their teaching and supplement this with materials they have prepared themselves. Of the materials available to them, teachers are using Exploring Science to the greatest extent. The reasons for the popularity of this set of materials are primarily teacher-centred reasons rather than pupil-centred reasons, although teachers feel the program meets pupils' needs satisfactorily. The other textbook-centred program, STEM, is less widely used and is considered to be a satisfactory program with neither outstanding strengths nor weaknesses. The Materials Based Program, whose origins in B.C. schools goes back to 1969, is favoured by a minority of teachers and is now less available than the other programs. This program has pupil-centred strengths which seem to produce a strong commitment to it among teachers.

The Contract Team urges school districts to make the materials for each of the three alternative programs accessible to all teachers and to encourage teachers to become familiar with these materials. Where teachers feel that the use of materials different from those they are now using would be advantageous, they should be encouraged to use them.

6.10 Instructional Practices

The last set of questions sought information about the ways instruction was carried on in classes, how pupils were evaluated, and how the quality of instruction might be improved.

6.10.1 Classroom Activities of Pupils

Question 55 asked teachers to indicate how often various science teaching activities were used in their teaching. Table 6.43 ranks these activities by the median of the frequencies reported. It is important to notice how two groups of activities dominate the higher ranking part of the list--activities in which teachers and pupils interact in a verbal fashion and activities which center around observation-experiment. For the latter group of activities, it is also important to note that the manipulative aspects (items ranked 6, 8, and 12) rank lower than the verbal and cognitive aspects (items ranked 2, 4, 5, and 10).

Measuring and graphing activities rank well down the list, and it is of concern that 12% of the teachers "Never" or "Rarely" engaged the students in measuring and that 25% of the teachers "Never" or "Rarely" had pupils prepare graphs in science. The Grade 4 Interpretation Panel, after examining pupil performance on the Assessment, stressed that both of these areas need more time and emphasis. The Contract Team is pleased to see that copying notes is well down the list.

Teachers do not often utilize the potential of the home as a place filled with useful objects where experimental activities can be done and it is disappointing to see the low ranking given to the activity of "Making up their own experiments". The failure of teachers to have pupils design their own experiments as a substantial component of science teaching is a significant contributor to pupils' failure to be able to Identify and Control Variables, as shown by the student achievement results in Chapter 4. The overall picture is, however, one of a wide variety of activities being utilized.

Table 6.43: Ranking of the Median Frequency with which Teachers Engage Students in Various Activities

1978 Rank	1982 Rank	Number of Question	Activity	1982 Median*
-	1	(5)	Interacting with the teacher in a mix of questions and explanations	4.51
1	2	(11)	Describing/reporting observations in their own words	4.05
16	3	(4)**	Listening to teacher's explanations	3.83
4	4	(8)	Making guesses about the results of an experiment	3.56
2	5	(9)	Interpreting or explaining for themselves the results of an experiment	3.48
3	6	(10)	Classifying objects or events	3.45
-	7	(16)	Watching audio-visual materials	3.28
6	8	(12)	Measuring in an experiment	3.23
7	9	(7)**	Generalizing information to new problem situations	3.19
5	10	(14)	Discussing experiment results with other students	3.16
14	11	(13)**	Answering questions from worksheets or textbooks	3.05
9	12	(1)	Carrying out experiments from a set of instructions	3.04
11.5	13	(19)	Reading from textbooks	3.02
10	14	(3)	Discussing the possible errors in an experiment that has been completed	3.01
13	15	(6)	Making a graph from the data students get from an experiment	3.00
8	16	(20)	Doing library research	2.99
15	17	(15)	Copying notes from blackboard/overhead projector	2.79
-	18	(21)	Going on field trips	2.78
11.5	19	(18)	Doing investigations at home	2.69
-	20	(22)	Discussing science issues and values in society	2.66
18	21	(17)	Memorizing scientific information	2.37
17	22	(2)	Making up their own experiments	2.32

* Scale is from 1 (Never) to 6 (Very Frequently)

** The corresponding 1978 questionnaire item was somewhat different

It is interesting to note that "Doing investigations at home" ranked much lower now than in 1978, as did "Doing library research". The latter may be another reflection of the decline in the adequacy of reading materials in science. The huge upward shift in listening as an activity may be due to the substitution of the neutral phrase, "to a teacher's explanations", in 1982 for the pejorative phrase "to lectures" in 1978 rather than to any real change in teacher or student behavior. This interpretation is reinforced by the first place ranking received by the new item, "Interacting with the teacher in a mix of questions and explanations". Two activities which have risen in ranking, "Answering questions from worksheets and textbooks", and "Reading from textbooks", are congruent with the trend of moving away from materials-based science to the use of textbook series.

It is also interesting to note that there were substantial differences between the rankings given to activities by secondary teachers (Table 7.27) as compared to elementary teachers. Secondary teachers have pupils classify less, and listen less, but require them to answer worksheets and textbook questions, to carry out experiments from instructions, and to copy notes to a greater extent.

The items ranked 1, 5, 9, 18, and 22 were examined by cross-tabulation to determine if experienced teachers engage in these activities with pupils more frequently than less experienced teachers. No consistent patterns were found. The same items were also cross-tabulated with Question 25 in which teachers indicated their current feeling of preparedness to teach science. Teachers who feel "Adequately" or "More than Adequately" prepared engage pupils in making up their own experiments more frequently than do other teachers. They also interact about science with their pupils more frequently, and require pupils to interpret and explain their data more often and to collect data by measuring more frequently. These are all desirable behaviors for pupils in science and this is additional evidence that good science teaching requires good preparation. The data in Table 6.43 partially explain why pupil performance in some areas of the achievement forms was disappointing, and therefore the Contract Team recommends that:

- elementary teachers of science provide pupils with many opportunities to

  --make measurements in experiments
  --graph experimental data
  --design their own experiments

Question 22, in addition to asking teachers about the availability of nine kinds of audio-visual equipment, also asked about the frequency of their use. Reference to Appendix H will show that, for most of the items listed, the response "Occasionally (1-5 Times/Unit)" was most frequently selected. This is another indicator that most teachers are using a variety of approaches in their teaching. The use of films and filmstrips "More Than 5 Times/Unit" by 25% of the teachers may indicate that some teachers are relying too heavily on teaching using vicarious rather than direct experience of nature. More than one-half of the teachers never use 35 mm slides and one-third of them never use video tapes. Both of these media have become increasingly available of late. Good materials have been produced and both are more flexible and adaptable than their traditional counterparts, the filmstrip and the movie film. Teachers should be encouraged to experiment with the use of these materials.

Question 54 asked teachers to indicate the access which they had to specific items of science equipment/supplies. The data are in Appendix H. It is important to remember that all of the items need not be available in all classrooms every year (although certain of them should). Plants, seeds, magnets, hand lenses, and thermometers seem to be accessible to most teachers. The fact that one teacher in eight either is unable to use or plans not to use thermometers at any time during the year is of concern, especially as Celsius temperature items were a problem for many pupils on the achievement forms. Balances and heat sources such as candles, alcohol burners, and hot-plates are less accessible and the number of teachers who would not have these available within the year is surprisingly large. The changes which heating produces and the measurements of weights and masses are very basic components of science. The absence of animals, aquaria, and terraria from between half and two-thirds of the classrooms is a matter of serious concern.

6.10.2 Provision of Individual Differences in Science

Question 56 asked teachers to report on provisions made in the "SCHOOL" for individual differences among pupils in science and Question 57 asked a similar question about the provision they made in their own "CLASS". The results in Appendix H indicate that two-thirds of the teachers work in schools where no school-wide provision is made for dealing with individual differences. The most common provision is in the form of modified and/or enriched programs available to about 23% of the teachers.

Over half of the teachers made no special provision for individual differences. Special interest groups were used by 28% of the teachers, individualized instruction by 22%, and achievement grouping by 19%. Teachers using other methods most frequently mentioned that they adapted their work and achievement expectations to the abilities of the pupils, or that they used projects, including Science Fair projects, as a provision for individual differences. Only one teacher mentioned the existence of a Science Club.

Cross-tabulations showed that the length of teaching experience did not affect the provision made for individual differences, that size of the largest science class did not affect provision, but that teachers who felt "Adequately" prepared or "More than Adequately" prepared were far more likely to make provision for individual differences than were teachers who felt less than adequately prepared.

Considering our current knowledge about the large variation in the ability of pupils to cope with the conceptual demands of science, the Contract Team feels that teachers ought to be giving more attention to provisions for individual differences.

6.10.3 Evaluation of Pupil Achievement in Science

Thirteen sources of data for the evaluation of pupils were listed in Question 58 and teachers were asked to indicate, on a four-category scale, the emphasis which they placed on each in deriving a final evaluation for their pupils. Table 6.44 shows the ranking of these methods by the median of the emphasis reported.

Table 6.44: Emphasis Placed on Various Sources of Data in Deriving Final Evaluations

1978 Rank	1982 Rank	Number of Question	Sources of Data	1982 Median*
3	1	(3)	**Anecdotal records of work habits	3.01
2	2	(4)	Teacher-made objective tests	3.00
1	3	(2)	**Anecdotal records of general attitude in class	2.98
6	4	(1)	Anecdotal records of achievement	2.89
4	5	(10)	Projects	2.88
8	6	(7)	**Activity/experiment write-ups	2.74
5	7	(9)	Reports on topics in science	2.71
7	8	(11)	Oral Tests	2.03
9	9	(6)	Subjective tests	2.02
10	10	(12)	Student self reports	1.46
12	11	(5)	Standardized objective tests	1.40
11	12	(8)	Individual work contracts	1.38
-	13	(13)	Attendance	1.31

* Scale from 1 (No Emphasis) to 4 (Much Emphasis)
** Wording of item differs slightly between 1982 and 1978.

These items fall into three groupings. Those ranking from 1 to 7 receive "Some Emphasis" or "Much Emphasis" by more than 60% of the teachers, and some combination of these forms the basis for the final grade given by most teachers. Oral tests and subjective tests are used less frequently. The high ranking of Question 3 is a cause for concern, if teachers are including these "Anecdotal records" as a part of pupils' letter grades because letter grades refer only to academic achievement.

Items ranking 10 to 13 are unused by over half of the teachers and receive "Little Emphasis" by most of the others. The 1978 rankings are not markedly different from those for 1982 indicating that classroom teachers' evaluation practices have remained stable since the last Assessment. The low ranking of individual work contracts reinforces the impression from the preceding section that individual differences in science are often being ignored.

6.10.4 Improving Learning in Science

Question 59 requested teachers to rate 23 changes which might affect the quality of science learning in their classroom. The question was identical to that asked in 1978 except for the replacement of one item. Table 6.45 ranks the ratings received by the median values on a five-point scale. All items except the last four were perceived by most teachers as more likely to improve the quality of learning than to harm it. Over 60% of the teachers rated the first 12 items as likely to improve the quality of education. Many of these changes also had high rankings among junior secondary school teachers. Many of these have been suggested as areas for change by the Contract Team earlier in the report. The major area of concern not previously stressed relates to teacher's workload--time, number of subjects/levels, and class size. The Contract Team urges districts and school administrators to seek ways of improving the conditions for science teaching, especially with respect to maintaining small classes and providing teachers with more in-school time for preparation.

Table 6.26 and the discussion in section 6.6.5 also describe another listing of suggestions for change which should be studied in conjunction with this section.

6.11 Teachers' Comments

Evidence that the questionnaire was carefully answered was shown by the number of teachers making comments. Thirty-five percent of those completing the questionnaire made one or more comments. Twenty-five percent used the space provided at the end. Many of the comments suggested ways to modify questions or to add options. A few were critical of the questionnaire. In the free response section, certain items of concern, identified earlier in this chapter, dominated the comments. These concerned the lack of equipment and its poor quality, the time pressures on teachers, space and storage problems, and teachers' lack of preparation for science teaching. Table 6.46 briefly summarizes the most frequent comments from Question 60.

Table 6.45: Teachers' Ratings of Changes Which Would Affect the Quality of Science Learning

1978 Rank	1982 Rank	Number of Question	Suggested Change	1982 Median*
4	1	(11)	More time to prepare and mark	4.38
**	2	(20)	Especially designed classroom for science	4.27
1	3	(9)	Increased provision of in-service	4.07
3	4	(4)	Smaller class size	4.06
7	5	(21)	Fewer subjects/levels to teach	4.05
2	6	(19)	Increased availability of equipment and materials	4.04
6	7	(14)	More university courses in science (taken by yourself)	3.86
5	8	(10)	More science books in library	3.84
11	9	(13)	More convenient storage space for equipment	3.78
8	10	(2)	Better quality of equipment	3.75
10	11	(6)	More coordination at school level	3.74
22	12	(5)	Provision of wider selection of printed materials (texts)	3.73
13	13	(17)	More time allocated to science	3.62
19	14	(15)	Higher priority placed on science by administration	3.60
9	15	(7)	More coordination at district level	3.55
20	16	(12)	Fewer classes to teach	3.50
12	17	(1)	More direct input by you into the purchase of equipment	3.48
21	18	(23)	More choice for teacher in the selection of the program	3.46
18	19	(18)	Changes in the new program	3.36
15.5	20	(8)	Decreased emphasis on the core curriculum	3.06
17	21	(3)	Less responsibility for maintenance of equipment	3.04
15.5	22	(22)	Increased emphasis on core curriculum	3.02
14	23	(16)	Less in-service education	2.47

* Scale is from 1 (Deteriorate Seriously) to 5 (Improve Greatly)
** New item; no 1978 ranking.

Table 6.53: Summary of Frequent Teacher Comments

Frequency	Comments--Condensed
In area of equipment, space and storage	
65	- lack of equipment or poor quality of equipment
42	- lack of space with classroom or school
32	- need a science room
6	- well equipped
In area of texts	
18	- lack of sufficient texts
13	- do not like texts available
8	- like program
7	- should be one text rather than three programs
5	- all materials should come as package deals
In area of other resources	
13	- need idea or unit books done by teachers
6	- need more reference books
6	- need more pupil reference books
5	- need more ready-made materials/aids
5	- need more locally developed units
5	- have locally developed units, and approve of them
In area of coordination and specialization	
20	- need science specialists
16	- have and approve of district-level coordinated program
12	- have and approve of a science coordinator
9	- need a district-level coordinated program
In area of teachers own time, competence and needs	
53	- lack of classroom time for science
37	- lack preparation time
31	- lack knowledge
22	- need in-service workshops
In other areas	
27	- need more hands-on activities
24	- need an integrated approach
17	- lack of continuity from K-8 in school, or district or province
6	- need provincial goals that are concise, well specified and simple
5	- need to use the outdoor activities

CHAPTER 7

SECONDARY TEACHER QUESTIONNAIRE RESULTS

David R. Stronck

7.1 Development and Description of the Questionnaire

A questionnaire was prepared to identify the current context of science teaching in the secondary schools of British Columbia, to recognize current classroom practices, and to assess changes since the 1978 Assessment. The 1982 questionnaire had a total of 94 items of which 13 were newly developed. Many of the 81 repeated items had slight changes by the addition of more alternatives or by the grouping of some categories. The 94 items were grouped into ten sections.

7.2 Description of the Sample

A secondary science teacher was defined as one who taught at least one class of biology, chemistry, earth science, general science, or physics. Principals and district itinerant teachers were excluded. Teachers were classified as "junior secondary" if they identified, in Item 46, Science 8, 9, or 10 as the one class with which they had both recent and extensive experience. The selection of any other class (e.g. Biology 11) determined a "senior secondary" teacher.

One thousand fifty-five questionnaires were sent to 176 schools. Each principal was requested to distribute the questionnaires to appropriate science teachers.

Five hundred twenty-nine teachers (309 junior secondary and 220 senior secondary) completed the questionnaire. The return rate, considering an inflated shipping rate, was 77.5%. In 1978, 1409 teachers completed the secondary questionnaire. The reduction in the number of teachers involved between 1978 and 1982 was a result of B.C. participation in a Science Council of Canada study which utilized a teacher questionnaire. Schools involved in this sample were excluded from the teacher portion of the provincial assessment.

The responses of the teachers in 1982 are summarized as percentages in Appendix I. The percentages are based on those responding to each question. The number of missing responses is normally less than five percent of the total sample.

Question 6 of the questionnaire requested a description of the respondent's assigned position in the school. In the junior secondary schools, 75% of the respondents were regular classroom teachers and 19% were department heads. In the senior secondary schools, 73% of the respondents were regular classroom teachers; 22% were department heads. Only five percent of the respondents had other descriptions of their positions.

7.3 Teacher Background and General Information

7.3.1 Extent of Teaching Experience

Responses to Question 1 indicate that the senior secondary teachers had a median of 13 years experience (vs 11 years in 1978) and that junior secondary teachers had a median of 10 years experience (vs 8 years in 1978). Although the teachers in 1982 had more years of teaching experience at both levels of the secondary schools, the junior secondary teachers continued to be less experienced than the senior secondary teachers.

Both in 1978 and in 1982, senior secondary teachers were 94% male and six percent female (Question 2). In 1978, 12% of the junior secondary teachers were female; in 1982, 15% were female. Although the percentage of male teachers at the junior secondary level has decreased it is important to note that nine out of ten secondary science teachers are male.

Question 3 collected data on the ages of the teachers. Table 7.1 provides cross-tabulation data describing how the age of male teachers relates to their years of teaching experience.

Table 7.1: Cross-Tabulation of Males' Teaching Experience and Ages (Percentages)

Years of teaching Experience	Age in Years			
	29 or under	30-39	40 or over	Total
5 or less	10	6	0	16
6-10	2	19	2	23
11-15	0	19	7	26
16 or more	0	3	32	35
Total	12	47	41	100

A cross-tabulation table is not provided for the 62 female secondary science teachers in 1982 because 37 are in the most minimal category of age 29 years and under with 5 or less years of teaching experience. Only 9 female teachers are age 40 years or more and with 16 or more years of teaching experience. There are approximately twice as many males as females among the youngest and least experienced secondary science teachers.

Comparison with the 1978 Science Assessment shows significant median increases of two years of age and years of teaching experience. Furthermore, the percentages of males and females teaching at the senior secondary level show no significant changes since 1978. The Contract Team finds these data disappointing, both in terms of failure to recruit young people, and failure to retain those few women who start out teaching science. School districts are urged to recruit, over a period of years, in an attempt to obtain a better balance between male and female teachers of science.

7.3.2 Courses Taken in Methods of Teaching Science

Question 4 asked for information about the successful completion of university courses in the teaching of science. Results showed that science teachers in senior secondary schools have had greater preparation through science methods courses than the teachers in the junior secondary schools. Especially at the senior secondary level, there has been an increase in the percentage of science teachers with more than one science methods course during the four years between 1978 and 1982.

Responses to Question 5 showed that 56% of senior secondary science teachers completed their courses in the methods of teaching science more than ten years ago. On the other hand, only slightly over one-third of the junior secondary science teachers (36%) have completed their science methods courses more than ten years ago.

The Contract Team suggests that school districts urge those science teachers who have never completed a science methods course to do so. Opportunities for such activity should be provided. Moreover, 45% of secondary science teachers who completed methods courses more than ten years ago may need in-service courses or workshops to assist them in implementing new areas of science teaching.

7.3.3 Courses Taken in Various Science Subjects

Question 4 asked teachers to identify the university/college courses that they had successfully completed in four different areas: biological sciences, earth/space/general science, physical sciences, and other science or engineering courses.

Only the category of biological sciences provides directly comparable data between the questionnaire of 1978 and that of 1982. These data show little change during the four years although there is a weak trend toward the completion of more courses in biology. In 1982, the area "physical sciences" subsumed two areas of the 1978 questionnaire: chemistry and physics. Similarly in 1982, the area of earth/space/general science replaced three areas presented in 1978: astronomy, earth science, and general science.

The Contract Team (1978) described the completion of four to seven courses in one subject with fewer than four in the other subjects as an "adequate background." By accepting this definition, it may be concluded that a majority of the teachers (55%) in the junior and senior secondary schools have adequate backgrounds for understanding the biological sciences. There is little difference between junior secondary and senior secondary teachers in this subject. But in the physical sciences (1978 and 1982) the senior secondary teachers show more preparation. In 1982, 65% of the senior secondary teachers had more than three courses while only 41% of the junior secondary teachers had completed that many courses. There is relatively little difference between junior secondary and senior secondary teachers in their completion of courses in earth/space/general science and other science or engineering. The curriculum of the junior sciences requires additional preparation for many junior secondary teachers, especially in the physical sciences and in earth/space/general sciences.

7.3.4 The Nature of Science Teaching Assignments

Table 7.2 summarizes the responses of the teachers to Question 7. This table also summarizes the responses of the teachers in 1978 when they checked all science courses that they were currently teaching.

The data demonstrate a trend toward a higher percentage of teachers, both junior and senior, assigned to junior secondary courses. This trend to a higher percentage of teachers assigned to junior secondary courses probably reflects a further trend to more junior-senior schools and/or a decline in the demand for senior science courses. Regardless of the cause, greater percentages of teachers are now required to teach junior secondary science courses.

Question 8 asked teachers about current enrollment of students. Responses demonstrated that the senior secondary schools are usually much larger than the junior secondary schools. Forty percent of the junior secondary schools had fewer than 500 pupils while only 10% of the senior secondary schools had so few.

7.4 Coordination

7.4.1 Types of Within-School Coordination

Question 9 asked the teachers to describe the form of science coordination existing in their schools. Table 7.3 summarizes the responses of the teachers in the junior secondary schools and in the senior secondary schools both in 1978 and in 1982. The 1978 Science Assessment Contract Team had recommended: "That schools without leadership in science education . . . designate a successful science teacher as the school's science coordinator where this is feasible." The table shows a trend, especially at the senior secondary level, to implement this recommendation.

Table 7.2: Junior and Senior Secondary Science Teachers Reporting on Science Courses Taught (Percentages)

	Junior			Senior		
	Previously Taught	Currently Teaching		Currently Teaching		Previously Taught
Course	1982	1978	1982	1978	1982	1982
Grades K-3	4	0	0	0	0	6
Grades 4-7	27	2	6	0	0	15
Science 8	89	65	70	13	21	73
Science 9	88	68	67	20	22	78
Science 10	80	40	63	31	42	88
Biology 11	28	11	8	38	34	50
Biology 12	18	7	4	32	29	40
Chemistry 11	24	10	6	34	34	53
Chemistry 12	12	6	4	26	27	36
Physics 11	18	6	3	27	30	39
Physics 12	11	3	2	18	19	26
Earth Science 11	4	3	2	9	9	14
Geology 12	1	0	0	2	3	6

There is a strong relationship between the size of the school and the type of coordination that usually exists. Cross-tabulation data (between Questions 8 and 9) demonstrate that the most common situation in small schools (fewer than 250 pupils) is no particular form of coordination. In these small schools, 34% had no form of coordination and 27% had coordination assumed by one of the regular classroom teachers. Of the schools with more than 1000 pupils, 92% had specially designated science department heads responsible for secondary grades only. These data suggest that the secondary schools of British Columbia may now be achieving the recommended goal of designated coordinators in almost all schools of medium to large enrollments.

Table 7.3: Science Coordination in Schools in 1978 and 1982 (Percentages)

Form of coordination in the school	Percentages of Teacher Responses			
	Junior		Senior	
	1978	1982	1978	1982
Designated science coordinator just for secondary grades	63	67	66	81
Designated science coordinator for elementary and secondary grades	2	2	0	1
Designated coordinator for science and one more other subject	10	9	14	7
Coordination by a working group of teachers in the school	13	9	10	5
Coordination assumed by the principal, vice-principal or one of the teachers	3	8	1	2
No particular form of coordination	8	5	7	4
Other	2	0	2	1

7.4.2 Adequacy of Within-School Coordination

Question 10 asked the teachers to rate the form of coordination checked in Question 9 for the school's science program. Table 7.4 summarizes the responses of the teachers both in 1978 and in 1982. The data show a weak trend toward more teachers rating the form of coordination as "Very Good" or "Excellent". Only 6% of the teachers describe the coordination as "Unsatisfactory" or "Very Unsatisfactory".

Cross-tabulation data help to explain the increasing percentage of teachers giving higher ratings to the form of coordination by showing that an increasing percentage report specially designated science department heads. This form of coordination had the highest levels of ratings: 22% of these teachers rated it as "Excellent", 42% as "Very Good", and 17% as "Unsatisfactory" or "Very Unsatisfactory". The next highest ratings for within-school coordination were for the relatively rare situation (eight responses) of a designated science coordinator for elementary and secondary grades.

Table 7.4: Adequacy of School Science Coordination in 1978 and 1982
(Percentages)

	Percentages of Teacher Responses			
	Junior		Senior	
Ratings of the form of coordination in the school	1978	1982	1978	1982
Very Good or Excellent*	51	57	55	58
Satisfactory	45	37	39	36
Unsatisfactory or Very Unsatisfactory*	8	6	7	6
		N** = 305		N = 219

* Five response categories were collapsed to three.
** N = number responding

7.4.3 Coordination at the District Level

Question 11 asked the teachers to describe the form of coordination for the secondary science program which exists at the district level. Table 7.5 summarizes their responses. The data show that since 1978 there has been a decrease in the category of "No particular form of coordination" by 13%. This reduction has been accomplished primarily by designating a supervisor for science and one or more other subjects, and secondarily by designating a science coordinator for elementary and secondary grades. Although there has been a significant trend toward designating district science coordinators, almost half of the teachers reported that their districts have not acted on the recommendation of the 1978 Contract Team "That districts appoint a capable science teacher as a science coordinator for the district where this has not already been done."

7.4.4 Adequacy of Coordination at the District Level

Question 12 asked the teachers to rate the form of coordination described in their response to Question 11. Table 7.6 summarizes their responses at the junior secondary level and the senior secondary level both in 1978 and in 1982. Table 7.7 provides the cross-tabulation of responses to Question 12 on satisfaction with the form of district coordination and Question 11 on the form of district coordination. Where the district has no particular form of coordination, few of these teachers rate the situation as "Excellent" or "Very Good" while over three quarters of these teachers rate the situation as "Unsatisfactory". No other category has even a majority of responses rating the form of coordination as "Unsatisfactory" or "Very Unsatisfactory".

Table 7.5: Forms of Science Coordination at the District Level
in 1978 and 1982 (Percentages)

Form of coordination in the school district	Junior 1978	Junior 1982	Senior 1978	Senior 1982
Designated science coordinator for just the secondary grades	10	9	9	10
Designated science coordinator for elementary and secondary grades	2	9	4	6
Designated coordinator for science and one or more other subject	7	14	10	17
Coordination by a working group of teachers in the district	17	16	16	14
Coordination assumed informally by one of the administrators or teachers in the district	4	4	4	5
No particular form of coordination	57	45	56	43
Other	3	3	3	6
		N* = 293		N = 217

* N = number responding

Table 7.6: Adequacy of District Coordination in Science Education
in 1978 and 1982 (Percentages)

Rating of the form of coordination in the school district	Junior 1978	Junior 1982	Senior 1978	Senior 1982
Very Good or Excellent*	14	10	11	11
Satisfactory	41	42	44	47
Unsatisfactory or Very Unsatisfactory*	46	49	45	43
		N** = 277		N = 206

* Five response categories were collapsed to three.
** N = number responding

Cross-tabulation data in Table 7.7 show that in districts with "specially designated science coordinator, supervisor or consultant responsible for just the secondary school science teachers", 27% of teachers rated the district coordination as "Excellent" or "Very Good". This was the only type of coordination without any rating of "Very Unsatisfactory". In terms of teachers' satisfaction, the next best form of coordination is the "specially designated science coordinator, supervisory or consultant who is responsible for elementary and secondary grades". All other types of district coordination had more "Unsatisfactory" ratings than "Excellent" or "Very Good" ratings.

The Contract Team repeats the recommendation made in 1978:

- That districts appoint a qualified individual as a science coordinator for the district where this has not already been done

Table 7.7: Teacher Satisfaction with the Type of District Coordination (Percentages)

Form of coordination at the district level for secondary science program	Ratings: Excellent or Very Good	Satisfactory	Unsatisfactory or Very Unsatisfactory	Total
Designated science coordinator for just the secondary grades	3	6	1	10
Designated science coordinator for elementary and secondary grades	3	5	2	10
Designated coordinator for science and one or more other subjects	2	9	5	16
Coordination by a working group of teachers	2	11	4	17
No particular form	1	9	31	41
Other	0	4	3	7
Total	11	44	46	101
				N* = 574

(Chi square = 159.6, df. = 10, p < .01)
* N = number responding

7.5 Physical Facilities, Materials and Equipment

This section is divided into five parts. Each subsection deals specifically with one aspect of physical facilities, materials, and equipment. Questions deal with adequacy, safety, funding, reading materials, and audio-visual equipment.

7.5.1 Adequacy of Physical Facilities, Materials and Equipment

Question 13 asked the teachers to rate the adequacy of the physical facilities, materials, and equipment in their schools. More than 75% rated the following six as "Adequate or better": lighting, electrical outlets, gas outlets, flat-topped desks or tables, audio-visual equipment, and chalkboard space. Nine of the nineteen types were rated as "Adequate or Better" by more than 50% but fewer than 75% of the teachers: storage space for science materials/equipment, storage space for microscope slides, science preparation room, water outlets, sinks or drainage facilities, safety equipment, amount of work space per student, fume hood/closet, and bulletin board space. The data show a problem of lack of storage space, facilities for water, and safety equipment.

Only four of the physical facilities, materials and equipment were rated by the majority of teachers as less than adequate. Slightly fewer than half of the teachers had less than adequate storage space for volatiles or had ventilation deficiencies. This situation must be the cause of some concern and the Contract Team suggests that it be rectified immediately. Of less importance is the absence of microcomputers, storage space for them, and storage space for student projects.

The teachers' responses to Question 13 show that many junior secondary schools have less than adequate water outlets, electrical outlets, gas outlets, sinks or drainage facilities, bulletin board space, and microcomputers.

Question 16 asked the teachers to identify how often in the past year they had to adapt their teaching plans because of difficulty in obtaining the necessary science equipment. Seventy-nine percent of the senior secondary teachers never or seldom had to adapt their plans and only 67% of the junior secondary teachers gave similar responses. The responses in 1982 were similar to those recorded in 1978.

Question 17 requested a rating for the quality of the science materials and equipment available to the teachers. Table 7.8 shows the responses of the teachers both in 1978 and 1982. In both assessments, the senior secondary teachers rated their materials and equipment more highly as "Excellent" and "Very Good" than did the junior secondary teachers.

Table 7.8: Rating of the Quality of the Science Materials/Equipment available in Secondary Schools (Percentages)

Quality of the science materials/ equipment available in the schools	Junior 1978	Junior 1982	Senior 1978	Senior 1982
Excellent	15	16	20	20
Very Good	59	37	60	46
Satisfactory	22	40	17	31
Unsatisfactory	3	6	2	2
Very Unsatisfactory	1	1 N = 293	1	1 N = 217

Therefore the Contract Team recommends that:

- school districts make a determined effort to effect improvements in the quality of science materials and equipment, especially in the small junior secondary schools

Table 7.9 gives the cross-tabulation of responses to Question 8 (size of school enrollment) by Question 17 (the rating of the quality of the science materials and equipment). The data demonstrate that highest levels of satisfaction are found in schools with enrollments between 250 and 750 students while the least satisfaction is found in schools with fewer than 250 students.

Table 7.9: Ratings of Quality of the Science Materials/Equipment by School Size (Percentages)

Ratings of the quality of science materials/equipment available in the school	Pupils enrolled in school: fewer than 250	250-750	over 750	Total
Excellent and Very Good	2	28	28	58
Satisfactory	4	19	14	37
Unsatisfactory and Very Unsatisfactory	1	2	3	6
Total	7	49	45	101

(Chi-square = 22.4, df = 4 < .001)

7.5.2 Safety Equipment

Question 15 asked the teachers to check all items of safety equipment in the science teaching area/room/laboratory. Table 7.10 summarizes their responses both in 1978 and 1982. The data show a clear improvement in the provision of many items. This trend is commendable although the Contract Team seeks complete adequacy of all appropriate safety equipment. For example, only 11% of secondary teachers report having sand buckets and scoops, despite their relative inexpensiveness.

Only 60% of the teachers have first aid kits, although these kits are probably the most frequently used of all types of safety equipment. While fire blankets are needed to save lives, only 72% of the teachers reported having this relatively inexpensive item.

The Contract Team strongly recommends that:

- the Ministry of Education establish safety standards for school science classrooms, and provide funds for school districts not only to conduct surveys of the science safety equipment in schools where science is taught but also to correct deficiencies that may be discovered through such surveys.

Question 14 asked: "How systematically is the safety equipment in your science area/room/laboratory checked?" In 1978, 63% reported systematic checking while in 1982 only 56% had systematic checking. Obviously, this trend toward less checking of the safety equipment is a serious problem.

The Contract Team urges district administrative personnel to ensure that systematic check be conducted in all science teaching areas to ensure all equipment etc. functions properly.

7.5.3 Funding and Obtaining Science Materials and Equipment

Question 18 asked the teachers how much input they had in deciding what science materials and equipment are to be purchased for their school. There is no significant difference between responses of junior secondary and senior secondary teachers. There also is no significant difference between the responses in 1978 and those in 1982. In 1978, 13% of the junior secondary teachers had virtually no input or not enough; in 1982, 14% gave these responses. In 1978, 12% of the senior secondary teachers had virtually no input or not enough; in 1982, 11% gave these responses. It is unfortunate that over 10% of the teachers have not contributed ideas about the purchase of science equipment.

Question 19 requested the teachers to identify who maintains and accounts for the science materials and equipment in the school. Table 7.11 summarizes the responses of the teachers for 1978 and for 1982. At the junior secondary level, the most common situation is to let the head of the science department look after it all (38%). Only 26% of the senior secondary schools use that system. In the senior secondary schools, the situation where all teachers of science look after their own materials and equipment or where each teacher of science looks after certain materials and equipment is most popular.

Question 21 asked about possible difficulties in obtaining science materials and equipment when they are needed. There were no significant differences between the responses of the junior secondary teachers and those of the senior secondary teachers. It is a concern that 21% of the teachers in 1982 found it "Somewhat difficult" to obtain science materials and equipment; fewer than 3% described it as "Very difficult". Their responses show progress since 1978 when more than 25% of the teachers explained that it was "Somewhat difficult", and 8% of the senior secondary teachers said it was "Very difficult". At the junior secondary level, there continues to be 3% of the teachers who say it is "Very difficult".

Table 7.10: Types of Safety Equipment Present in Science Teaching Areas

	Junior		Senior	
Type of Safety Equipment	1978	1982	1978	1982
No safety equipment	1	2	3	1
Fire blankets	54	81	44	62
Fire extinguisher	94	93	92	95
Master gas shut-off	88	91	86	91
Master water shut-off	28	27	24	31
Approved first aid kit	52	57	61	67
Safety goggles	56	83	54	71
Asbestos gloves	17	25	19	26
Sand buckets and scoops	12	11	9	8
Eye-wash stations	74	82	68	79
Acid spill clean-up kit	--	10	--	14
Safety charts	--	47	--	46
Demonstration safety shield	--	17	--	20
		N* = 308		N = 220

* N = number responding

In response to Question 24, both in 1978 and in 1982, 14% of the senior secondary teachers said that they did not have enough money allocated to their science programs to teach the programs properly. In 1978, 12% of the junior secondary teacher made this same complaint while in 1982 only 10% of these teachers had this problem.

Table 7.11: Responsibility for Maintaining and Accounting for Science Materials/Equipment (Percentages)

Who maintains and accounts for the science materials/equipment in the schools	Junior		Senior	
	1978	1982	1978	1982
Each teacher of science looks after his/her own	23	16	42	24
Each teacher of science looks after certain materials/equipment	10	14	13	26
A specially designated teacher looks after it all	9	8	4	3
Head of science department looks after it all	37	38	20	26
Paid assistants look after it all	15	15	16	14
There is no policy on who is responsible	2	5	1	4
Other	5	4	4	3
		N* = 282		N = 197

* N = number responding

7.5.4 Science Reading Materials and Audio Visual Aids

Question 22 asked the teacher to rate the adequacy of the science reading materials in their schools. Table 7.12 summarizes their responses both in 1978 and 1982. Unfortunately, the data show a strong shift toward inadequacy during the last four years. In 1978, only 24% of all secondary science teachers described the science reading materials in their schools as "Very Inadequate" or "Somewhat Inadequate". In 1982, 50% of the junior secondary teachers and 39% of the senior secondary teachers gave these poor ratings.

The Contract Team therefore recommends that:

- school districts encourage school libraries to purchase an adequate supply of science reading materials in the secondary schools.
- teachers and school librarians be encouraged to cooperatively explore the upgrading of print materials in science

Table 7.12: Adequacy of Science Reading Materials (Percentages)

Adequacy of science reading materials in the school	Junior 1978	Junior 1982	Senior 1978	Senior 1982
Very inadequate	5	15	5	10
Somewhat inadequate	19	35	19	29
Satisfactory	50	44	46	47
More than adequate	25	6	31	14
		N* = 304		N = 221

* N = number responding

Table 7.13 gives cross-tabulation data demonstrating that satisfaction with the adequacy of the reading materials significantly increases with the increasing numbers of pupils enrolled in the school.

Table 7.13: Adequacy of Science Reading Materials by School Size (Percentages)

Number of pupils enrolled in the school	Very or somewhat inadequate	Satisfactory or more than adequate	Total
Fewer than 250	5	3	8
250-750	25	24	49
Over 750	17	27	44
Total	47	54	101

(Chi square = 13.6, df = 2, $p < 0.01$)
N = 525

Question 23 requested a rating of the use of various audio-visual aids in the teaching of science. The overhead projector was certainly the audio-visual aid most used; 50% of the teachers used it "Frequently (more than 5 times/unit)". Films, large charts, models, video tapes, and filmstrips were the next most popular aids; except for filmstrips they were more used by the senior secondary teachers than by the junior secondary teachers. The junior secondary teachers made greater use of filmstrips and 35 mm slides.

7.6 Science Teaching

7.6.1 Worth and Importance of the B.C. Science Program

Question 26 asked the teachers to give their opinions on how worthwhile the prescribed B.C. science program is to the pupils they are presently teaching. Table 7.14 summarizes their responses. Both in 1978 and in 1982, the senior secondary science teachers perceived the science program as more worthwhile than did the junior secondary teachers. The junior secondary teachers have improved their ratings of the program during the last four years, probably because of their widespread favour toward the Grade 9 textbook. Unfortunately, the senior secondary teachers have significantly lowered their ratings of the B.C. science program.

Table 7.14: Worth of Prescribed B.C. Science Program
in 1978 and 1982 (Percentages)

Ratings of the prescribed B.C. science program to pupils presently under instruction	Junior		Senior	
	1978	1982	1978	1982
Very worthwhile	22	26	43	34
Of some worth	65	65	55	61
Of little worth	11	6	3	4
Practically worthless	3	3	0	0
		N* = 300		N = 215

* N = number responding

7.6.2 Teachers' Assignments

Question 27 asked teachers for their ONE choice of grade level that they would prefer to teach science. In 1978, 91% of the senior secondary teachers were content to teach at that level while seven percent preferred the post-secondary level. In 1982, 94% of the senior secondary teachers would choose to teach science at the senior secondary level with only five percent wanting post-secondary assignment. The junior secondary teachers differ significantly from the senior secondary teachers by preferring a change. Their first choice, made by 40%, is to teach in a combined junior-senior secondary school. Teaching in a junior secondary school was their second choice at 33% while 17% would choose a senior secondary school. Responses in 1978 from the junior secondary teachers were similar. Teaching at the junior secondary level remains unattractive to many.

Question 28 considers how well teachers felt prepared to teach science. Among the 304 junior secondary teachers, 20 were only "Somewhat" or "Not at all" prepared. The Contract Team suggests that administrators assist teachers who are poorly prepared either to be placed in other subjects or to receive adequate preparation.

Cross-tabulation data demonstrate that poorly prepared teachers never rate secondary science as "More important than all other subjects" while 29% of teachers with "More than adequate" preparation give this rating.

In response to Question 29, the teachers described their teaching assignments according to various categories. For example, 60% of the senior secondary and 43% of the junior secondary teachers taught only science. There were similar responses to this category in 1978. The other three categories show a strong trend toward increasing specialization in teaching science. The trend is most obvious for the last category, "Teaching science less than 25% of the time". In 1978, 21% of the junior secondary teachers were in this category while only 10% had this assignment in 1982. In 1978, only 26% of the junior secondary teachers taught science 50% or more of the time. In 1982, 32% of these teachers had such an assignment. The same trend is clearly found in the senior secondary schools where 14% of the teachers in 1978 were teaching science less than 25% of the time; in 1982, only three percent had such an assignment.

Sixty percent of the 526 secondary teachers are teaching only science. The remainder of the sample was invited to specify in Question 30 the other part of their assignment. At the junior secondary level, 59% of the 181 teachers were also teaching mathematics. At the senior secondary level, 65% of the 94 teachers were also teaching mathematics. The remaining teachers had assignments besides their science load in the following sequence of frequency: other subjects, counselling and/or administration, and physical education.

Question 35 asked for an identification of special science programs existing in the schools. The two most common special programs were special learning assistance for low achievers, and modified science courses for pupils leaving school during junior high school years and for low achievers. All other special programs are only about one-third as commonly reported as the two most common special programs, which have increased greatly since 1978. The senior secondary schools offer technology-oriented science courses (e.g. forestry or mining) twice as often as do the junior secondary schools. Recreational science courses and special electives for advanced pupils have had few changes during the last four years.

7.6.3 Teachers' Suggestions for Changes

Question 34 is important because it asks the teachers to suggest possible changes in their school's science program. The 1978 questionnaire listed 17 aspects of science programs for the junior secondary teachers. The 1982 questionnaire repeated 15 of these aspects and added six for consideration by both the junior secondary and the senior secondary teachers. The responses of these teachers are summarized in Table 7.15. The table presents medians for the three-point scale where one equals "less", two equals "same", and three equals "more". In other words, a median of 2.0 averages the responses to a recommendation for no change. Almost all of the interquartile ranges are between .75 and 1.00.

As shown in Appendix I, in 1982, more than 75% of the secondary science teachers wanted more provision of print materials other than textbooks. This concern reinforces the recommendations in Section 7.5.4. More than two-thirds of these teachers wanted more provision for meeting the needs of gifted children, more background information for teachers, and more emphasis on the impact of science on society. Over 50% of these teachers suggested more alternate programs in science, more specialist science teachers in elementary schools, and more provision for meeting the needs of handicapped children. Almost half of these teachers wanted more integration of science with other subject areas. The Contract Team joins the teachers in their concerns, and strongly urges that the suggested changes be made wherever possible. In particular, the Contract Team further urges the Ministry of Education to continue to explore with the British Columbia Science Teachers' Association ways to prepare and provide background information to teachers as has been done in the provision of the source book for junior science teachers.

Table 7.15: Changes in the School's Science Program Suggested by Teachers (Medians)

Aspects of the school's science program*	Junior				Senior	
	1978		1982		1982	
	Median	Rank	Median	Rank	Median	Rank
1. Provision of print materials other than textbooks	--	--	2.88	1	2.80	1
2. Integration of science with other subject areas	2.46	6	2.50	9	2.48	7
3. Discovery learning	1.98	15	2.00	20	1.88	21
4. Activity-centred learning	2.16	10	2.19	16	2.11	16.5
5. Alternate programs in science	2.70	2	2.78	4.5	2.68	6
6. Locally developed programs	2.57	4	2.45	10.5	2.19	14.5
7. Outdoor education	2.56	5	2.45	10.5	2.22	11
8. Teaching of basic science concepts	2.34	7	2.24	13	2.32	9
9. Teaching of science processes (e.g., classifying)	2.24	8	2.20	14.4	2.20	12.5
10. Definition of core curriculum	2.13	11	2.20	14.5	2.11	16.5
11. Background information for teachers	2.76	1	2.78	4.5	2.75	3
12. Provincial learning assessment	2.00	14	1.97	21	1.96	20
13. District learning assessment	2.09	13	2.03	19	2.02	19
14. Freedom for teacher to define course	2.12	12	2.08	18	2.10	18
15. Teacher input into purchase of equipment	2.21	9	2.15	17	2.19	14.5
16. Environmental education	2.59	3	2.55	8	2.20	12.5
17. Field trips	--	--	2.40	12	2.24	10
18. Provision for meeting the needs of gifted children	--	--	2.85	2	2.79	2
19. Provision for meeting the needs of handicapped children	--	--	2.64	7	2.36	8
20. Specialist science teachers in elementary schools	--	--	2.67	6	2.69	5
21. Emphases on the impact of science on society	--	--	2.79	3	2.72	4
	N** = 932		N = 304		N = 219	

* Scale from 1 (low) to 3 (high)

** N = number responding

7.7 Teacher Education

This section deals with pre-service and in-service education of teachers.

7.7.1 Adequacy of Pre-Service Teacher Education Program

Question 36 asked the teachers to rate the adequacy of their pre-service education program as a preparation for teaching secondary science. Table 7.16 summarizes the responses of the junior secondary and senior secondary teachers both in 1978 and 1982.

Table 7.16: Adequacy of Pre-Service Teacher Education Program (Percentages)

Rating of adequacy of pre-service teacher education program	Junior		Senior	
	1978	1982	1978	1982
Very inadequately*	23	21	24	16
Somewhat inadequately	32	35	25	33
Adequately	33	36	37	42
More than adequately	11	8	14	10

* The responses from the 1978 Assessment result from combining two categories: "Very inadequate" and "I had no teacher education in science".

Question 37 asked teachers how much emphasis they felt SHOULD be placed on a series of 23 statements in preparing student teachers to teach science. After establishing what "SHOULD" be emphasized, Question 38 asked: "How much emphasis WAS placed on each of the following in your pre-service preparation period for the teaching of science?" The same list of techniques and topics followed both Questions 37 and 38. Responses to both questions are summarized in Table 7.17.

The data are presented in this table to allow a direct comparison between columns describing what "SHOULD" be emphasized and what "WAS" emphasized.

Table 7.17: Emphasis That SHOULD Be and WAS Placed On Techniques and Topics in Preparing Student Teachers to Teach Science

Techniques and topics rated on a scale*	Junior Secondary		Senior Secondary	
	SHOULD	WAS	SHOULD	WAS
1. Techniques of teaching science	3.69	2.38	3.66	2.64
2. Techniques for developing reading skills in science	2.90	1.15	2.86	1.12
3. Techniques for developing writing skills in science	2.85	1.13	2.91	1.14
4. Subject matter in specific areas of science	3.08	2.58	3.52	2.85
5. General science	3.05	2.27	3.03	2.19
6. History & philosophy of science	1.96	1.30	2.20	1.38
7. Psychology of learning	2.41	2.26	2.63	2.55
8. Testing/evaluating/grading in science	2.93	2.13	3.04	2.29
9. Psychology of adolescence	2.47	1.93	2.43	2.21
10. Theories of intellectual development	2.05	1.79	2.09	1.79
11. Survey of available curriculum materials	2.81	1.70	2.90	1.86
12. How to develop curriculum materials	2.91	1.38	2.93	1.58
13. Lesson planning	3.18	2.72	3.32	2.82
14. Preparation of science materials	3.16	1.90	3.14	2.10
15. Practice in teaching science	3.85	2.87	3.85	2.99
16. Discussion of problems of science teaching	3.23	1.76	3.22	1.91
17. Care and maintenance of animals in the classroom	2.15	1.09	2.07	1.09
18. Care and maintenance of equipment	2.55	1.14	2.46	1.18
19. Laboratory safety	3.32	1.39	3.32	1.39
20. Special education	1.72	1.06	1.65	1.07
21. Integration with other subjects	1.79	1.12	2.34	1.11
22. Use of community resources	2.54	1.22	2.44	1.22
23. Use of audio-visual materials	2.79	2.04	2.82	1.93

* Scale is from 1 (very little emphasis) to 4 (heavy emphasis)

The nineteenth category "Laboratory safety" had the largest difference between what "SHOULD" be and what "WAS" emphasized. With identical medians and interquartile ranges, both the junior secondary teachers and the senior secondary teachers clearly described this topic as insufficiently emphasized in their pre-service preparation. On the four-point scale there was almost a two-point difference between what "SHOULD" be done and what "WAS" done. The Contract Team therefore strongly recommends that:

- faculties of education give greater emphasis to preparing pre-service teachers in the topic of laboratory safety.

All medians of the teachers' responses were lower in describing what "WAS" emphasized in comparison with what "SHOULD" be emphasized on all of the topics. In addition to Laboratory safety, there were ten other categories where the differences between "SHOULD" and "WAS" were greater than one full point on the four-point scale. In rank order, with the category having the largest difference given first, they are: techniques for developing writing skills in science, techniques for developing reading skills in science, how to develop curriculum materials, discussion of problems of science teaching, care and maintenance of equipment, use of community resources, techniques for teaching science, preparation of science materials, survey of available curriculum materials, and care and maintenance of animals in the classroom. The Contract Team recommends that:

- Faculties of Education give greater emphasis to each of the techniques and topics identified by teachers to be most inadequately emphasized in their pre-service training.

7.7.2 In-Service Education

Question 39 asked the teachers to describe how much in-service education they felt they required during the current year to do a good job of teaching science. Both in 1978 and in 1982, most of the teachers expressed a need for some in-service education. In 1982, 45% of the secondary teachers wanted either several sessions of three to five hours or an intensive refresher course. A majority of those wanting in-service education prefer several sessions of three to five hours.

Question 40 requested that the teachers classify 13 different forms of in-service according to a scale where one point equalled "Little Value", two points equalled "Moderate Value", and three points equalled "Much Value". Table 7.18 summarizes the responses of both junior secondary and senior secondary teachers. The medians on the three-point scale were calculated without including those who had not experienced a form of in-service. For example, the majority of science teachers in the secondary schools have never had a workshop presented by Ministry of Education officials.

Table 7.18: Forms of In-Service Experienced and Valued by Junior Secondary and Senior Secondary Teachers (Percentages and Medians)*

Form of in-service program	Junior Percent NOT experienced	Junior Median	Junior Rank	Senior Percent NOT experienced	Senior Median	Senior Rank
1. Informal meetings with other science teachers	1	2.39	1	1	2.68	1
2. Informal meetings with university science education instructors	39	2.61	11	20	1.86	9.5
3. Informal meetings with scientists	50	1.83	10	37	2.05	7
4. Workshops presented by other teachers	12	2.16	5	5	2.09	4
5. Workshops presented by university science educators	23	2.14	6	9	1.88	8
6. Workshops presented by district resource persons	37	1.87	8	34	1.86	9.5
7. Workshops presented by scientists	49	1.84	9	37	2.06	6
8. Workshops presented by Ministry of Education officials	67	1.42	12	45	1.59	12
9. University credit courses in science content	18	2.26	3	12	2.42	2
10. University credit courses in science methods	25	1.89	7	16	1.80	11
11. Visits to other classrooms	20	2.20	4	17	2.07	5
12. Annual conferences for science teachers	24	2.36	2	10	2.38	3

* Scale is from 1 (little value) to 3 (much value)

Question 41 requested a rating of the effectiveness of the science in-service education activities in the school/district. Both in 1978 and in 1982, approximately 39% of the secondary teachers had no in-service education activities in their schools or districts for the teaching of science. Teachers with such activities judged them much more effective in 1982 than four years earlier. In 1978, only 25% of the junior secondary teachers who experienced in-service rated the programs as "Fairly effective" or "Very effective", while in 1982 46% of these teachers made this judgement. In 1978, 31% of the senior secondary teachers rated the activities as "Fairly effective" or "Very effective"; in 1982, 46% made this judgement. Although there has been an improvement in the perceived effectiveness of in-service education, the majority of teachers remain dissatisfied. They continue to want improvement.

Each of the five most valuable forms of in-service was rated as of "Much Value" by at least 24% of the teachers and of "Moderate Value" or of "Much Value" by at least 67% of the teachers. In their rank order beginning with the most valued of the forms were informal meetings with other science teachers, annual conferences for science teachers, university credit courses in science content, visits to other classrooms, and workshops presented by other teachers.

"Annual conferences for science teachers" was not listed on the 1978 questionnaire. The other highly rated forms of in-service were among the first five ranked in 1978. Although annual conferences for science teachers were ranked as the second most valued form of in-service, 24% of the junior secondary teachers have not had the opportunity to attend such a conference. The Contract Team suggests that school districts make such conferences available to more teachers.

Questions 42 and 43 asked the teachers to describe their willingness to participate in in-service education under three different types of conditions: "After School Hours", "On Weekends", and "during school hours IF RELEASE TIME WERE GIVEN". Both in 1978 and 1982, only five percent of the secondary teachers probably or definitely would not participate in an in-service workshop provided during school hours if release time were given. In 1982, 84% of the secondary teachers would probably or definitely participate in an in-service education workshop during after-school hours. The junior secondary teachers differed significantly from the senior secondary teachers only in their acceptance of weekend workshops; 59% of the senior secondary teachers and 68% of the junior secondary teachers probably or definitely would participate on weekends. The responses in 1978 were very similar to those in 1982.

The data indicate that a substantial proportion of the teachers feel a need for a sustained in-service program and most indicate a willingness to participate in such a program.

Present in-service programs were often unavailable to teachers or were often rated as ineffective. Therefore the Contract Team recommends that:

- the Ministry of Education coordinate the design, development, and delivery of in-service programs for teachers focused on some of the needs pointed out in the 1982 Science Assessment.

7.8 Assessment and Testing

Section F of the questionnaire contains two questions (44 and 45) on the 1978 B.C. Science Assessment. In responses to the first question, approximately half of the secondary teachers of science read the provincial Summary Report. Somewhat fewer (43%) read the district's interpretation report on this Assessment. Slightly fewer than one fourth of these teachers read either of the provincial General Reports, Volume 1 on student surveys and Volume 2 on teacher surveys. Although these percentages may seem weak, they are superior to the responses from teachers of other subjects. While 50% of the secondary science teachers read the 1978 Summary Report on the Science Assessment, only 45% of the secondary English teachers read the 1977 Summary Report on the Reading Assessment and only 41% of the secondary mathematics teachers read the 1977 Summary Report of the Mathematics Assessment.

Although the secondary science teachers have a higher percentage reading the Summary Report, the secondary teachers of both English and Mathematics responded that their Assessments in 1977 had a greater impact on their schools. On Question 45, between 52% and 91% of the science teachers checked the columns indicating that they did not know what impact the Assessment had or that it had no impact on any of the educational factors listed. Little impact of any great significance was noted in any area. This is a very disappointing finding which causes concern.

The Contract Team feels that a larger proportion of teachers of science should have a chance to review aspects of the Assessment. Therefore, the Team urges that copies of both the Provincial Summary Report and the District Interpretation Report be made directly available to teachers of science in the district.

7.9 Junior-Secondary Program

The Contract Team notes, with approval, the fact that the Ministry of Education has acted upon the 1978 recommendation for a Junior Secondary Curriculum revision and that such a revision is almost completed.

7.9.1 Grade 8

In response to Question 46, 117 teachers identified Science Grade 8 as the one class with which they had both recent and extensive experience. Only these teachers answered Questions 47 and 48. Question 47 asked for the teachers' reaction to the current Grade 8 text, Introducing Science Concepts in the Laboratory. Almost two-thirds (66%) of these teachers were "Moderately satisfied" or "Very satisfied" while 21% were "Moderately dissatisfied" or "Very dissatisfied". The Contract Team notes and approves that the Ministry of Education is planning to replace the Grade 8 text within two years.

Question 48 asked teachers how many hours their Grade 8 classes usually spent on each of the four sections of the junior secondary curriculum. In 1982, the four listed sections were for chemistry, biology, earth science, and physics (light). In 1978, the questionnaire asked the same question but included a fifth section on measurement. Table 7.19 compares the medians of the hours for each section between the responses of 1978 and those of 1982. There is no change in the ranking of the four major sections of the Grade 8 science curriculum within these four years. The slight increases in time for each of these sections in 1982 may be explained by the deletion of the section on measurement which appeared only on the 1978 questionnaire.

The Contract Team is concerned about the neglect of earth science which is given less than 20 hours by 27% of the teachers. Only 12% of these teachers give so little time to the next most neglected topic, physics (light). The General Report of the 1978 Science Assessment observed that, at the grade eight level, earth sciences seem to have been neglected. In 1982, the conditions have remained essentially unchanged. Therefore the Contract Team recommends that:

- junior secondary teachers give greater time emphasis to earth science topics

Table 7.19: Hours Spent by Grade 8 Pupils on Each Section of the Junior Secondary Curriculum in 1978 and 1982

	1978		1982	
Section of the curriculum	Median hours	I.Q.R.*	Median hours	I.Q.R.*
Chemistry	29	12.2	32	4.9
Biology	27	11.6	29	9.1
Physics: Light	27	11.9	29	13.7
Earth Science	22	15.3	25	15.4
Measurement	10	12.7	(not listed in 1982)	
Total	115		115	

* Inter Quartile Range

7.9.2 Grade 9

In response to Question 46, 95 teachers identified Science Grade 9 as the one class with which they had both recent and extensive experience. Only these teachers answered Questions 49, 50, and 51.

In response to Question 49, 87% of these teachers described the revised Grade 9 science text as better than the previous edition. Only three percent responded that the revised edition is worse, therefore one may conclude that the revision is highly successful. Responses to Question 50 indicate that 71% of these teachers use the practical application suggestions in the revised Grade 9 science text by Schmid and Murphy from one half to almost all of the time.

Teachers' answers to Question 51 listed time spent by teachers on the various sections of the curriculum. The data apparently demonstrate that the revised Grade 9 science text has increased the teaching of astronomy by more than seven hours while the other topics were adjusted accordingly. This apparent trend is an improvement in accordance with the 1978 Contract Team's recommendation for more time devoted to Space Science.

7.9.3 Grade 10

In response to Question 46, 95 teachers identified Science Grade 10 as the one class with which they had both recent and extensive experience. Only these teachers answered Questions 52 and 53. Table 7.20 summarizes their responses to Question 52 which asked about the usefulness of different printed materials. The same table also compares their responses with those to the same question in the 1978 B.C. Science Assessment. All of the materials listed on both questionnaires show some loss in perceived usefulness during the last four years.

Table 7.20: Usefulness of Printed Materials for Grade 10 Science (Percentages)

	Cannot say or of little use		Useful or very useful	
Printed material	1978	1982	1978	1982
Mixtures in Chemistry (Harrison, Murphy)	74	81	27	18
Ecology: Field Research in Science (Jacobson et al.)	79	93	22	7
Investigations in Science Modules (Wiley Series)	92	93	9	7
Extending Concepts in the Laboratory (Rasmussen & Schmidt)	not listed	39	not listed	61

The teachers' responses to Question 53 are summarized in Table 7.21. The same table also contains data from the identical question of the 1978 questionnaire. During the last four years, there has been little change in the allotment of time for each section of the Grade 10 science curriculum.

Table 7.21: Hours Spent by Grade 10 Pupils on Each Section of the Junior Secondary Curriculum

Section of the Curriculum	1978 Median hours	1978 I.Q.R.*	1982 Median hours	1982 I.Q.R.*
Radioactivity	6	5.6	5	5.3
Electricity and Magnetism	29	23.8	25	7.5
Atoms, Molecules and Ions	28	13.5	26	12.8
The Planet Earth (Earth Science)	14	16.1	15	13.0
Cells, Reproduction and Heredity	33	13.0	34	16.9
Sound and Wave Motion	12	12.5	9	11.0
Total	122		114	

* I.Q.R. = Inter Quartile Range

The 1982 questionnaire did not directly provide a question on the teachers' satisfaction with the Grade 10 Science textbook. Nevertheless, Question 94 at the end of the questionnaire invited "any other comment on the science program." In response to this last question 33 of 95 teachers of Grade 10 Science requested an immediate change of the textbook. No teacher made any comment of support for this textbook. The Contract Team notes with approval the plans of the Ministry of Education to replace this textbook within one year.

7.9.4 Supplementary Reading Materials

Questions 54 to 56 were completed by all teachers of the junior secondary science program. These three questions consider supplementary reading materials that may be used at Grade 8, 9, or 10.

Table 7.22 summarizes responses to Question 54. It also summarizes responses to the same question on the 1978 teacher questionnaire. During the last four years, the data show a large decrease in the use of the Reading About Science series. Nevertheless, this series remains the most commonly used supplemental reading material.

Table 7.22: Teacher Use of Reading About Science Series (Percentages)

Use of Reading About Science Series	1978	1982
Never use it or make it available to pupils to read as they wish	18	40
Recommend certain readings without follow-up	17	14
Assign readings to discuss in class or to test in class	65	47

Question 55 asked the teachers' opinions about four different characteristics of the background reading materials for the Reading About Science series. Similar questions appeared in the 1978 questionnaire. In 1978, 50% of the teachers responded that the background reading materials were "Too difficult." In 1982, two percent more held that opinion. In 1978, only 12% of the teachers described these materials as "Out-of-date"; in 1982, 27% made this description. Sixty percent of the teachers in 1978 said that the materials were "Not relevant to lab topics"; 54% made this statement in 1982. In 1978, 22% believed that the materials were "Generally satisfactory"; 34% gave this rating in 1982.

Question 56 dealt with the usefulness of six different sets of alternate materials that are not available through Publication Services Branch of the Ministry of Education. The 1978 questionnaire did not list the recently published Canadian Cancer Society Package which is currently being used in about 18% of the B.C. junior secondary schools. The popularity of "Locally developed units" has remained unchanged during the last four years. However, the other four sets of materials (B.C.T.F. Lesson Aids, Searching for Structure Series, Intermediate Science Curriculum Study, and Independent Investigations in Science) had reductions in perceived usefulness by 9%, 5%, 8%, and 5%. In response to Question 55, the teachers expressed concern about the series Reading About Science becoming "Out-of-date." If the same reasoning applies to the materials listed within Question 56, then the decline of usefulness may be explained in terms of their age. Because locally developed units tend to be produced randomly and relatively continuously, their popularity among teachers may not be reduced by the aging process.

7.10 Senior-Secondary Program

7.10.1 Biology 11

Questions 57 to 62 were answered by 66 biology teachers. Question 57 asked the teachers to classify each of the texts according to the frequency of their use on a three-point scale and Question 58 asked them to rate their suitability. Table 7.23 summarizes their responses. According to this table, the most frequently used book is Animals Without Backbones. The next most frequently used book is the B.C.S.C. Biological Science: An Ecological Approach, currently used as the basic textbook by a majority of teachers.

Table 7.23: Use and Suitability of Texts in Biology 11 in 1978 and 1982
(Medians and Percentages)

Texts used	Use in 1982 Median*	Suitable** 1978	Suitable** 1982
1. B.S.C.S. Biological Science: An Ecological Approach (green version)	2.45	67	59
2. B.S.C.S. Biological Science: Inquiry into Life Lab Text (yellow version)	1.95	88	73
3. B.S.C.S. Biological Science: Molecules to Man (blue version)	1.09	29	33
4. Laboratory and Field Investigations (Miller and Vance)	1.34	55	48
5. Laboratory Manual Biological Science: (Gregory)	1.95	80	72
6. Laboratory Outlines in Biology (Abramoff and Thomson)	2.04	83	82
7. B.C. Curriculum Guide for Biology 11	1.98	75	61
8. Animals Without Backbones (Buchsbaum)	2.84	97	97
9. Resource Book of Test Items	1.58	55	53
10. Student Lab Outline (Ministry of Education)	1.24	41	37
11. A Guide to the Study of Freshwater Biology (Needham and Needham)	1.95	86	78
12. Trees, Shrubs, and Flowers to Know in B.C. (Lyons)	1.98	90	87
13. B.S.C.S. Lab Block: Life in the Soil	1.46	66	60
14. Botany: An Introduction to Plant Biology (Weier et al.)	1.92	not listed	57

* Scale is from 1 (never used) to 3 (regularly used)

** These columns give the combined percentages of responses to the two ratings of "Suitable" and "Very Suitable".

Table 7.24 summarises teacher responses to the question concerning the amount of time spent in Biology 11 on each of the four sections of the course.

Table 7.24: Hours Spent by Biology 11 Pupils on Each Section of the Course in 1978 and 1982

	1978		1982	
Section of the curriculum	Median hours	I.Q.R.	Median hours	I.Q.R.*
Ecology	21	13.7	22	19.3
Diversity	34	10.5	41	18.0
Evolution	9	11.6	10	12.5
Optional material	10	12.9	11	11.4
Total	74 N** = 114		84 N = 47	

* I.Q.R. = Inter Quartile Range
** N = number responding

Data in Table 7.24 show an interesting trend toward the teaching of more "Diversity" within Biology 11. Certainly the popular book Animals Without Backbones supports such instruction.

In response to Question 60, 61% of the teachers advocated including more on the topic of human biology than is present in Biology 11. In 1978, only 53% of the Biology 11 teachers gave a similar response. Question 61 asked the teachers about the possibility of developing an alternative course, concentrating on human biology, for the Grade 11 level. In 1982, 78% favored such a new course; in 1978, only 64% made this same recommendation. Question 62 asked if the respondent would teach such a course if it were an option. Although 92% said "Yes" in 1978, only 88% said "Yes" in 1982. However, in 1982, nine percent replied "Not sure" while this category of response was not available in 1978. In general, there has been growing support for the introduction of a Human Biology 11 course.

7.10.2 Biology 12

Questions 63 through 66 were answered by 50 biology teachers. Question 63 asked the teachers to classify each of the texts according to their use on a three-point scale. Table 7.25 gives the medians for the teachers' responses to this question. It also gives data on the suitability of these texts according to the responses of the teachers to Question 64 in 1982 and the same question in 1978. Comments from the teachers indicate that the most frequent complaint about Biology 12 (in response to Question 94) is the out-of-date content of some books. Forty-four per cent of these teachers rate the most commonly used book, Foundations in Biology, as "Unsuitable".

Question 65 asked the teachers to describe the amount of time spent in Biology 12 on each of the four sections of the course. In 1978, 56% of the 67 respondents reported 50 or more hours on physiology; in 1982, 74% of the 50 respondents reported that many hours on this topic. The only other section receiving much attention is cellular biology. In 1978, 15% gave cellular biology 50 or more hours while in 1982 only six percent gave that many hours to it. Most of the teachers are giving no time or very little time to either evolution or optional materials. Biology 12 could be renamed Physiology 12 to describe its dominant topic.

In response to Question 66, one-half of the teachers in 1982 said that Biology 12 has "Too much content". Four years earlier, only 36% reported this problem. In 1982, almost half of these teachers believe that Biology 12 has an appropriate balance between content and process.

The senior secondary biology curriculum has not been revised in recent years. The textual materials available are losing favour with biology teachers and there are indicators that the content of the courses should be re-examined. Therefore the Contract Team recommends that:

- the Ministry of Education establish a Senior Secondary Biology Revision Committee to re-examine all aspects of the senior secondary biology curriculum

Table 7.25: Use and Suitability of Texts in Biology 12 in 1978 and 1982
(Medians and Percentages)

Printed materials used in Biology 12	Use in 1982 Median*	Suitable** 1978	Suitable** 1982
1. Investigations of Cells and Organisms, A Laboratory Study in Biology (Abramoff, Thomson)	2.33	62	60
2. Foundations in Biology (McElroy et al.)	2.90	78	56
3. B.C. Curriculum Guide for Biology 12	2.26	not listed	
4. Botany: An Introduction to Plant Biology (Weier et al.)	2.19	not listed	77
5. Other sources of materials (N = 37; 13 not reporting)	2.70	93	87
6. Workbook of Investigations of Cells and Organisms	not listed	37	37
7. Dissection of the Fetal Pig	not listed	96	96
8. Dissection Guide for the Fetal Pig	not listed	99	96

* Scale is from 1 (never used) to 3 (regularly used)

** These columns give the combined percentages of responses to the two ratings of "Suitable" and "Very Suitable".

7.10.3 Chemistry 11 and Chemistry 12

Questions 67 and 68 were answered by 75 chemistry teachers. Both of these questions deal with a list of textbooks and laboaratory manuals. Teachers were asked to rate the use of texts in Chemistry 11 and Chemistry 12. Because some of the texts appeared in both lists, Table 7.26 summarizes responses to both questions.

Table 7.26: Use of Textbooks in Chemistry 11 and Chemistry 12 (Medians)

Textbook used in chemistry with their laboratory manuals	Chemistry 11 Medians *	Chemistry 12 Medians
Inquiries in Chemistry (Turner, Sears)	2.68	1.41
Foundations of Chemistry (Toon, Ellis)	1.61	2.96
Laboratory Experiments for Foundations of Chemistry (Toon, Ellis)	not listed	2.78
Keys to Chemistry--lab manual (Ledbetter, Young)	1.46	not listed
Keys to Chemistry--text (Ledbetter, Young)	1.43	not listed
The Nature of Matter (McDonald, Courneya)	1.44	not listed
Keys to Organic Chemistry (Addison Wesley)	1.34	not listed
Proton Chemistry (Richardson)	not listed	1.58

* Scale is from 1 (never used) to 3 (regularly used)

7.10.4 Physics 11 and Physics 12

Questions 69 and 71 were answered by 66 physics teachers. Question 69 asked the teachers to classify the use of textbooks and laboratory manuals in Physics 11 and Question 71 asked the same for Physics 12.

In September 1981, a new Physics 11 program was introduced. For teaching the new Physics 11 course the textbooks are Fundamentals of Physics and The Ideas of Physics. In response to Question 70, 44% of the physics teachers described the new Physics 11 course as "Much improved" over the previous course; 34% found it "Slightly improved". While 78% of these teachers believed that there has been an improvement, only eight percent responded that the new course is worse.

Both Chemistry 11 and Physics 11 now have curricula designed to serve the interests of many pupils who are not enrolling in Chemistry 12 or Physics 12.

7.10.5 Earth Science 11 and Geology 12

Nine teachers answered the two questions covering Earth Science 11 and Geology 12. In 1978, there were 19 teachers in this category. Because of the small number, the 1978 questionnaire had only the following question for them: "If you teach Earth Science 11 or Geology 12, please comment freely on these courses." One of the comments was a recommendation that Geology and the New Global Tectonics by J. R. James be required. This book is described in 1982 as the most commonly used in Geology 12. Responses show that Earth Science by Goldthwait is the majority's (75%) choice for regular use in Earth Science 11.

In 1978, the two most frequently made comments about the geology curriculum were that the course is often viewed as a dumping ground for students not taking chemistry, physics, or biology. The course content tends to overlap with that learned in others such as geography. Apparently, Earth Science 11 is often used to serve the same function that a General Science 11 course would serve.

7.10.6 General Science 11

All of the teachers of senior secondary science courses (N = 225) were asked to respond to three questions on a general science course for Grade 11. The teachers were asked to describe their view on the introducation of a general science course at the Grade 11 level. In 1978, 61% of the teachers favoured such an introduction; in 1982, 59% approved it. In 1978, 14% of the teachers thought that such a course would be a waste of time and money; in 1982, 16% held that same opinion.

The majority of senior secondary science teachers during the last four years have supported the introduction of a general science course at the Grade 11 level and seem prepared to teach it.

However, responses to the question on initiation of such a course show that few such courses have started. Over 90% of the teachers reported that no such course had been initiated or even planned. Only five percent reported that a general science course was in place. The purpose of such a course would be to serve the needs of non-college-bound pupils through an emphasis on technology-oriented topics and the needs of college-bound, non-science majors through an emphasis on the inter-relationships between science and society. The introduction of General Science 11 would suggest a review of the reduced rigor recently incorporated in the new Chemistry 11 and Physics 11 programs. The Contract Team suggests to the Ministry that the K-12 Science Advisory Committee be asked to consider the advisability of developing a General Science 11 course.

7.11 Instructional Practices

This section is divided into six sub-sections. Each sub-section deals with questions regarding aspects of instructional practice such as homework assignments, marking and grading practices, and time tables.

7.11.1 Activities Done by Pupils

Question 77 asked the teachers to describe how often they engage their pupils in various activities. They indicated the amount of involvement by classifying each activity according to a six-point scale. Table 7.27 summarizes the responses of junior and senior secondary teachers both in 1978 and 1982 on 22 activities.

More than one-half of the teachers in 1982 reported using five activities "Frequently" or "Very Frequently". In rank order from the most used to the least used, they are interacting with the teacher in a mix of questions and explanations, answering questions from worksheets or textbooks, carrying out experiments from a set of instructions, describing/reporting observations in their own words, and measuring in an experiment. These rankings are from a composite of responses from both junior and senior secondary teachers in 1982. The most frequently used activity was not listed on the 1978 questionnaire. The second ranked activity (answering questions from worksheet or textbooks) has had a very major increase at both the junior and the senior secondary levels since 1978. The third activity (carrying out experiments from a set of instructions) has declined especially at the senior secondary level since 1978. On the other hand, the fourth ranked activity (describing/reporting observations in their own words) has had a major increase at the senior secondary level. The Contract Team sees this change in the management of experiments at the senior secondary level as an improvement.

Based on the suggestions of the Interpretation Panel discussed in Chapter 5 and on current frequency of use reported in this question, the Contract Team suggests greater use of the following activities:

(a) making up (or designing) experiments
(b) graphing pupil-obtained data
(c) generalizing information to new situations
(d) solving quantitative problems.

This suggestion is particularly pertinent for junior secondary teachers who use such activities significantly less than senior secondary teachers. Cross-tabulation data show that teachers with more than 15 years experience use graphing activities and quantitative problems more frequently than less experienced teachers.

Table 7.27: Frequency of Engaging Pupils in Various Activities by Teachers 1978 and 1982 (Medians)*

Activities done by pupils.	Junior 1978	Junior 1982	Senior 1978	Senior 1982
1. Carrying out experiments from a set of instructions	4.78	4.68	4.48	4.03
2. Making up their own experiments	1.74	1.84	1.81	1.89
3. Discussing the possible errors in an experiment that has been completed	3.42	3.47	3.75	4.60
4. Listening to teacher's explanations	2.90	4.02	3.43	4.38
5. Interacting with the teacher in a mix of questions and explanations	--	4.56	--	4.73
6. Making a graph from the data students get from an experiment	2.88	2.82	3.17	3.20
7. Generalizing information to new problem situations	3.15	3.16	3.43	3.41
8. Making guesses about the results of an experiment	3.19	3.26	3.10	3.13
9. Interpreting or explaining for themselves the results of an experiment	4.00	4.22	4.00	4.23
10. Classifying objects or events	2.77	2.95	2.71	2.94
11. Describing/reporting observations in their own words	4.58	4.51	4.27	4.64
12. Measuring in an experiment	4.28	4.48	4.39	4.68
13. Answering questions from worksheets or textbooks	2.93	4.69	3.00	4.53
14. Discussing experiment results with other students	3.41	3.47	3.67	3.59
15. Copying notes from blackboard/overhead projector	3.04	3.19	3.17	3.41
16. Solving quantitative problems	3.20	2.98	3.50	4.05
17. Memorizing scientific information	2.68	3.06	2.63	3.11
18. Doing investigations at home	1.93	2.13	1.81	1.94
19. Reading from textbooks	2.99	3.21	3.23	3.30
20. Doing library research	3.36	2.52	2.40	2.52
21. Going on field trips	--	1.89	--	1.89
22. Discussing science issues and values in society	--	2.76	--	2.87

* Scale is from 1 (never) to 6 (very frequently--almost every class period)

Question 78 requested that the teachers identify provisions made in their schools for individual differences among pupils in science. The most common ways of providing for these pupils were through modified and/or enriched programs and through learning assistance classes. Unfortunately, 42% of the senior secondary teachers described their schools as providing nothing while only 19% of the junior secondary teachers described a lack of any special provisions in their schools.

Question 79 asked the teachers to describe provisions they made within their class for individual differences. There were no significant differences between the responses of the senior secondary teachers and those of the junior secondary teachers. Although a majority of these teachers (55%) made no special provisions, approximately one-third used indiviualized instruction.

7.11.2 Marking and Grading Practices

Question 82 asked the teachers to describe the proportion of the lab/experiment write-ups for their classes that receive detailed comments. Both in 1978 and in 1982, the senior secondary teachers gave more detailed comments. Between 1978 and 1982, the senior secondary teachers reduced the amount of detailed comments while the junior secondary teachers increased this practice. Table 7.28 summarizes the responses of the teachers.

Table 7.28: Proportions of the Lab/Experiment Write-Ups Receiving Detailed Comments (Percentages)

Proportion of the lab/experiment write-up receiving detailed comments from the teacher	Junior		Senior	
	1978	1982	1978	1982
None	5	6	3	2
Well below half	37	30	26	37
About half	29	29	25	24
Well over half	21	20	30	15
All	8	15	16	23

In response to Question 83, 82% of the secondary teachers explained that they give numerical marks as the most frequent method of marking lab write-ups for their science classes. At the junior secondary level, nine percent of the teachers give letter grades for marking lab write-ups. All other systems of marking are used by fewer than five percent of the teachers in either the junior secondary schools or the senior secondary schools.

Question 84 requested the teachers to describe, on the average, how manageable their marking load is in science. In 1982, 57% of the teachers said that it is sometimes manageable but sometimes unmanageable. Another eight percent described their marking load as usually unmanageable.

Table 7.29: Emphasis Placed on Various Behaviors in Deriving Final Evaluations for Pupils by Junior Secondary and Senior Secondary Teachers (Medians)

Rating of emphasis placed on each of the following behaviors in deriving final evaluation of pupils on a four-point scale	Junior		Senior	
	Median*	Rank	Median*	Rank
1. Anecdotal records of achievement	2.10	7.5	1.72	9
2. Anecdotal records of general attitude in class	2.10	7.5	1.73	8
3. Anecdotal records of work habits	2.27	4	1.96	4
4. Teacher-made objective tests	3.70	1	3.85	1
5. Standardized objective tests	1.39	10	1.79	7
6. Subjective tests (essay, paragraph, etc)	2.50	3	2.86	3
7. Laboratory/experiment write-ups	3.65	2	3.25	2
8. Individual work contracts	1.28	12	1.13	12
9. Reports on topics in science	2.23	5	1.95	5
10. Projects	2.20	6	1.92	6
11. Oral tests	1.34	11	1.19	11
12. Student self reports	1.15	13	1.11	13
13. Attendance	1.71 N = 293	9	1.60 N = 205	10

* Scale is from 1 (No emphasis) to 4 (Much emphasis)

Question 85 asked the teachers to describe the emphasis placed on various behaviors and techniques in deriving a final evaluation for pupils. Their responses are summarized in Table 7.29 (preceding). There are only two methods used that are given "Much emphasis": teacher-made objective tests and laboratory/experiment write-ups. Subjective tests (essay, paragraph, etc.) had "Some emphasis". All of the other alternatives were relatively rarely used.

It is of some concern that "Anecdotal records of work habits" ranks as highly as it does if those records are used as part of a final letter grade. Student achievement should not include anything except measures of academic success. Work habits could be reported separately. A similar comment could be made for "Anecdotal records of general attitudes in class".

In responses to Question 86, the teachers described on the average the percentages of pupils in the science class who are expected to receive each of the final letter grades for the course (grades A, B, C+, C, P, and F). The senior secondary teachers gave a substantially larger percentage of grade A and grade B. Otherwise, there were minimal differences between the grades given by the junior seondary teachers and the senior secondary teachers.

7.11.3 Homework Assignments

Question 87 asked the teachers to describe how many hours of homework in science they assigned to each pupil in an average week. Both in 1978 and 1982, the senior secondary teachers gave significantly more hours of homework. Since 1978 the junior secondary teachers have remained approximately unchanged in the hours of assigned homework while the senior secondary teachers have reduced the number of hours.

Question 88 requested that the teachers describe the frequency of use of various types of homework assignments. In general, the teachers have continued over the four-year period to make very similar use of the variety of possible homework assignments. The senior secondary teachers continue to assign primarily the problems at the end of the section or chapter while also making relatively frequent use of lab/experiment write-ups and completing work unfinished in class. The junior secondary teachers continue to make the greatest use of lab/experiment write-ups and completing work unfinished in class with some lesser emphasis on assigning problems at the end of a section or chapter. Although the junior secondary teachers made greater use of assignments such as doing at-home experiments and preparing reports on topics in science, unfortunately these assignments were rarely used by either junior secondary or senior secondary teachers.

7.11.4 Time-Table

Question 90 asked the teachers about their satisfaction with the amount of time given to complete the curriculum for their science course. In 1982, 43% of the secondary teachers did not have enough time; in 1978 only 38% of the comparable teachers lacked enough time.

Question 91 asked the teachers to identify the time-table pattern of their school for their science course. In 1978, 50% of the teachers reported that their schools had the semester system and 43% said their schools were using the regular full-year pattern. In 1982, 59% of the teachers reported that their schools were using the regular full-year pattern with only 33% of the teachers reporting the use of the semester system.

Question 92 requested that the teachers give their preference for a time-table pattern. In 1978, 54% preferred the regular full-year pattern; in 1982, 73% had this preference. The preference for the semester system declined from 34% in 1978 to 22% in 1982. There is a significant difference between the junior secondary teachers and the senior secondary teachers. The latter have the semester system more than twice as frequently (21% junior seondary and 50% senior secondary). Only 26% of the senior secondary teachers prefer the semester system while 19% of the junior secondary teachers gave this preference. The Contract Team encourages the Ministry to investigate the reasons for the teachers' disenchantment with the semester system.

Question 93 collected data on the number of pupils enrolled in a science class. The junior secondary teachers, both in 1978 and in 1982, had significantly larger numbers in the class than did the senior secondary teachers. During the four years, the trend has been toward smaller numbers in classes, especially at the junior secondary level. Table 7.30 gives details on class enrollments.

Table 7.30: Enrollment in Science Classes Reported by Junior Secondary and Senior Secondary Teachers in 1978 and 1982 (Percentages)

Number of pupils enrolled in one science class	Junior		Senior	
	1978	1982	1978	1982
20 or fewer	4	8	15	25
21-24	8	18	27	28
25-28	25	46	34	26
29-32	51	25	21	15
33 or more	13	4	4	7

7.11.5 Changes for Improving the Quality of Science Learning

Question 89 asked the teachers to rate 22 change statements in terms of their effects on the quality of science learning in their classrooms. Their responses are summarized in Table 7.31. In general there are only slight changes between 1978 and 1982. The junior secondary teachers, more strongly than the senior secondary teachers, advocated smaller class size, provision of a wider selection of printed materials (texts), more coordination at district level, and more university courses in science.

Table 7.31: Rating the Effects on the Quality of Science Learning of Various Change Statements (Medians*)

	Junior				Senior	
	1982		1978		1982	
Change statements	Median*	Rank	Median	Rank	Median	Rank
1. More direct input by you into the purchase of equipment	3.23	18	3.26	14	3.23	14
2. Better quality of equipment	3.61	11	3.68	7	3.61	8
3. Less responsibility for maintenance of equipment	3.13	19	3.08	17	3.19	15
4. Smaller class size	4.31	1	3.80	5	3.93	4
5. Provision of wider selection of printed materials (texts)	4.07	4	3.94	3	3.99	3
6. More coordination at school level	3.36	17	3.24	15	3.17	16
7. More coordination at district level	3.39	15.5	3.46	11	3.27	13
8. Decreased emphasis on core curriculum	2.98	21	2.88	18	2.98	18
9. Increased provision of in-service	3.88	5	3.85	4	2.85	19
10. More science books in library	3.62	10	3.63	8	2.49	22
11. More time to prepare and mark	4.18	2	4.05	2	4.17	1
12. Fewer classes to teach	4.11	3	4.13	1	4.11	2
13. More convenient storage space for equipment	3.45	14	3.44	12	3.45	9
14. More university courses in science (taken by yourself)	3.64	9	3.62	9	3.39	11.5
15. Higher priority placed on science by administration	3.39	15.5	3.27	13	3.39	11.5
16. Less in-service education	2.48	22	2.58	19	2.51	21
17. More time allocated to science	3.73	8	3.79	6	3.80	6
18. Changes in the new program	3.57	12	--	--	3.65	7
19. Increased availability of equipment and materials	3.76	6.5	--	--	2.73	20
20. Fewer subjects/levels to teach	3.76	6.5	3.48	10	3.85	5
21. Increased emphasis on core curriculum	2.99	20	3.09	16	3.00	17
22. More choice for teacher in selection of program	3.46	13	--	--	3.40	10

* Scale is from 1 (Deteriorate Seriously) to 5 (Improve Greatly)

7.11.6 Summary Comment on Instructional Practices

Regarding instructional practices, little has changed in four years, except that the economic condition of the times and the educational scene have produced a need to modify the recommendations from the 1978 Assessment. The 1982 Contract Team reiterates the need for secondary schools to obtain more time for science instruction and suggests that the semester system be re-examined in terms of its ability to provide adequate time. Teachers are encouraged to use homework in diverse, imaginative ways, and are urged to examine the amount of emphasis placed upon the routine assigning and marking of formal lab reports.

The Contract Team is concerned that difficult financial conditions will force school boards to take steps which may lead to deleterious situations. It is suggested that large classes, particularly at the junior secondary level, be kept at safe, manageable sizes. Where possible, it is urgent that allowance of time for preparation and marking at the secondary level be increased, not reduced, especially for those teachers now receiving less than three hours of preparation time per week.

The Contract Team strongly recommends in-service for teachers, in light of the "Marginal" results by secondary pupils on the achievement forms. Expansion of repertoire of teaching techniques, especially at the junior secondary level, is indicated, as in 1978. More urgent is the need for teachers to increase their use of activities such as designing experiments, graphing from pupil-obtained data, generalizing information to new problem situations, and solving quantitative problems.

7.12 Teachers' Comments

Table 7.32 records the frequency of comments made by the teachers in response to Question 94 which asked teachers to make additional statements.

Table 7.32: Individual Teacher Comments

Frequency	Curriculum--General
15	Science should be taught at two levels: academic and modified
9	Gifted pupils are being ignored
	Textbooks
11	Grade 8 Science textbook is inadequate
9	Grade 9 Science textbook is excellent
33	Grade 10 Science textbook needs immediate change
15	Biology 11 textbooks are inadequate
5	Replace BSCS Green Version with BSCS Yellow Version
16	Biology 12 textbook is out-of-date and contains errors
15	Chemistry 11 textbooks are inadequate
11	Chemistry 12 textbooks are inadequate
5	Replace present chemistry textbooks with CHEM Study
3	*Foundations of Chemistry* by Toon and Ellis is good for both Chemistry 11 and Chemistry 12
5	Physics 11 new program is good
8	Physics 11 new program lacks challenge for the better pupils
	Funding
12	Equipment is inadequate
3	Restrictions on maximum allowable costs of scientific items are destroying the quality of instruction
3	Laboratory technicians are necessary for a good science program
5	Banks of test items are needed
	In-Service
7	More in-service opportunities are needed

CHAPTER 8

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Robert M. Hunt, John J. Sheppy, and Hugh Taylor

8.1 Introduction

This final chapter attempts to highlight and integrate the major findings of the Assessment and, in so doing, to present a broad picture of the state of science instruction in the schools of British Columbia. Data upon which the chapter is based are found in the earlier parts of the report and in the appendices. A series of recommendations concludes the chapter.

8.2 Summary of Findings from Achievement Surveys

Nearly 80 000 pupils at three grade levels completed assessment forms which contained achievement items in three cognitive domains and scales in various affective areas. Interpretation Panels of informed individuals rated pupil performance on the assessment items and groups of items which constituted objectives and domains. The ratings were made on a five-point scale as follows:

Strong	ST
Very Satisfactory	VS
Satisfactory	S
Marginal	M
Weak	W

Table 8.1 summarizes the ratings over the three grade levels.

Pupil performance was not rated higher than "Satisfactory" in any domain at any grade level. In only two of the possible nine domain ratings were "Satisfactory" ratings given, and four of the ratings were "Marginal". Variability of performance on two domains was considered too great for a single rating to be meaningful and one domain received a "Marginal to Satisfactory" rating.

At the objective level, twenty-five ratings were given: four were "Very Satisfactory", eight were "Satisfactory", eleven were "Marginal" and two were "Weak". The overall ratings of objectives at the Grade 4 and Grade 8 levels were similar, with the Grade 8 being slightly weaker. The ratings at the Grade 12 level were much weaker than at Grades 4 and 8. The Interpretation Panel ratings indicate that pupils in British Columbia schools are achieving below the level at which informed judges feel they should achieve, and that the Grade 12 results are cause for serious concern.

Table 8.1: Summary of Interpretation Panel Ratings of Pupil Achievement Over Three Grades

Domain/Objective	Grade 4	Grade 8	Grade 12
Domain 1: Science Processes	S	No Rating*	M
Objective:			
Observe and Infer	VS	-	-
Classify	S	VS	-
Communicate	M	VS	-
Quantify	M	-	-
Interpret Data	-	S	M
Identify and Control Variables	-	W	S
Domain 2: Knowledge--recall and understand	M	No Rating*	M
Objective:			
Biological, Physical and Earth/Space Concepts	M	S	M
Applications of Science (Technology) and Nature of Science	S	M	S
Safety Procedures	M	W	M
Domain 3: Higher Level Thinking	S	M-S	M
Objective:			
Apply Biological, Physical and Earth/Space Science Concepts	S	S	-
Use Rational and Critical Thinking	VS	M	-
Evaluate Evidence for Conclusions	-	-	M
Solve Abstract Problems	-	-	M

* The Grade 8 Interpretation Panel felt that variability of performance within this domain was too great for a single rating to be meaningful.

8.2.1 Grade Four

The Grade 4 forms stressed achievement in four selected science processes. Pupils achieved very well on questions relating to observation and classification but only marginally on questions relating to communication in science (obtaining scientific information from graphs, tables, diagrams, prose selections, etc.) and to quantification.

The Assessment gave less stress to evaluating the knowledge domain but the Interpretation Panels actually found pupil achievement in the knowledge of basic science concepts to be disappointing.

For the level of knowledge which they possess, the Grade 4 pupils were judged to be able to apply knowledge satisfactorily and to be well able to employ the skills of critical thinking which were tested.

The overall picture from the Grade 4 data is that pupils are learning certain basic science processes well, that knowledge of concepts may be underemphasized and that pupils' higher level thinking is being adequately developed. The amount of time given to science in primary grades seems to be inadequate for doing the job well, and many teachers are not using as much time as they are allowed for science teaching. The weaknesses detected at this level would probably be corrected by increased emphasis on science at the classroom level.

8.2.2 Grade 8

The Interpretation Panel ratings for the objectives in Grade 8 were more variable than those at the other grades, and this variability led the Panel to feel that it could not give meaningful domain ratings in two of the domains.

Pupil achievement was considered to be very good in the two basic processes of classification and communication which are stressed in the primary grades and which continue to be developed in the intermediate years. The integrated processes are to be emphasized in grades four to seven. On the two integrated processes assessed, the pupils were judged to have achieved satisfactorily in the Interpreting Data items but to have achieved poorly in Identify and Control Variables questions.

The Assessment explored pupils' knowledge of science concepts quite extensively at the Grade 8 level, and the Interpretation Panels judged that pupils had a satisfactory knowledge of elementary science facts and concepts, with the exception that knowledge in earth science seemed weaker than in other areas. However, pupil knowledge of the uses of science and of the nature of science was judged to be only "Marginal".

The overall picture from the Grade 8 Assessment is that pupils are leaving elementary school with an adequate knowledge of basic science concepts, with an ability to apply this knowledge in simple situations, and with well developed skills in at least some basic processes. However, they have inadequate knowledge of the nature and utility of science, and they show less than satisfactory ability in scientific reasoning whenever the situation involves more than a single factor. They are not showing adequate ability to integrate knowledge or processes.

8.2.3 Grade 12

The Interpretation Panel judged achievement in all three domains at the Grade 12 level as "Marginal", and gave the same rating to five of the seven objectives. In only two areas was pupil performance considered to be "Satisfactory".

In the Science Processes domain, pupils' performance on the questions relating to the identification and control of variables was rated as "Satisfactory" in comparison with the "Weak" rating for this objective in Grade 8. The ability of the Grade 12 pupils to interpret data from graphs and tables was judged to be "Marginal". Since these two processes are vital to scientific thinking, it is disappointing that the results are not better for pupils so near the end of their public schooling.

Knowledge of scientific concepts was also judged "Marginal" as was their knowledge of safety procedures. The only "Satisfactory" rating in the knowledge domain was for knowledge of applications of science and the nature of science, an objective for which only six questions were asked.

In the higher level thinking domain (where pupils were required to apply scientific knowledge to new situations or to select appropriate conclusions based on data) the results were judged "Marginal".

The overall picture from the Grade 12 Assessment is very discouraging. No areas of pupil achievement were explored in which it could be said that the pupils were achieving better than "Satisfactory", and those areas of satisfaction identified in the Grade 8 Assessments in both 1978 and 1982 do not seem to have been maintained throughout the secondary school years. In fact, the 1982 Grade 12 pupils were the 1978 Grade 8 pupils of whom it was said

> "The evidence indicates that students enter secondary school with well-developed skills in basic processes and a satisfactory level of understanding of science concepts". (Science Assessment 1978, General Report, Volume 1 pg. 76)

Also, at the grade 8 level, about two-thirds of the pupils express a positive attitude to school science. It would seem that the two bases of adequate entering skills and good attitudes are not being adequately built upon in the teaching of secondary science.

A substantial number of Grade 12 pupils had completed or were about to complete their last formal course in science. It is disheartening, therefore, to know that many secondary school graduates do not have adequate knowledge of basic science concepts, cannot use some of the central processes of science adequately, and do not apply scientific knowledge well.

It must be remembered that the knowledge, processes, and thinking skills measured at Grade 12 were designed to be limited to those covered in the first ten grades, and that all of the Grade 12 pupils who have taken senior secondary courses were included among those who wrote the assessment instruments. Interpretation Panel judgements were made on the data for all Grade 12 pupils. The results for those pupils who had completed no science courses since Grade 10 are considerably lower, from 11% to 34% on the content area (page 129) averages, than the other Grade 12 pupils.

8.2.4 Safety

A consistent concern of the Interpretation Panels was the pupils' performance at all levels on the Knowledge of Safety Procedures items. Very high performance was expected on these items. Pupils usually failing to meet these expectations. The Interpretation Panel ratings at all three levels caused concern and several recommendations regarding safety are presented later in the chapter.

8.2.5 Comparisons to 1978

Because of differences in procedures in administering the achievement forms at the Grade 4 level, direct comparisons between 1978 and 1982 cannot be made. When judgements of the Interpretation Panels of the two Assessments are compared one finds that, in 1978 there was overall satisfaction with the success of the primary program, in 1982 there are a number of concerns as well as areas of strength.

The overall performance of Grade 8 pupils in 1982 was very similar to that in 1978 on assessment questions which were repeated, and on these the 1982 Interpretation Panels' ratings, made independently of 1978 ratings, were similar to those in 1978. The areas in which change was assessed were given "Satisfactory" ratings. The areas of weakness in the Grade 8 pupils' achievement which are causing concern in 1982 are areas which were not assessed in 1978.

The overall performance of Grade 12 pupils in 1982 was approximately two percent below 1978 performance on the items which appeared in both Assessments. However, the overall 1982 Panel ratings, while higher than those of 1978, indicate serious weaknesses in pupil achievement. It would be fair to say that, while the 1982 Panel had lower expectations for Grade 12 performance, Grade 12 pupils were falling below these expectations. The 1978 General Report made the following summary comment:

> "Apparently many students leave school with limited understanding of some very fundamental concepts. Also, the evidence indicates that during the secondary grades, the abilities to design and interpret experiments do not develop much beyond the level attained at Grade 8. Perhaps this may relate to a finding from the teacher survey that secondary students spend most of their science classes doing experiments from instructions, and seldom design their own experiments. Another area of poor performance is knowledge of practical applications of science, possibly

> indicating an overemphasis on the formal theoretical aspects of science in the secondary grades. Finally, the very weak results obtained by girls in the areas of physics and earth/space science should give cause for concern. Present science offerings and teaching practices need to be investigated to determine to what extent the educational system is at fault in failing to teach girls important physical science concepts".
> (Hobbs et al, 1979: 94)

The statement above still holds true in 1982.

8.2.6 Sex-Related Differences in Science

The outstanding finding of the analysis of achievement results by gender was that there is a significant and substantial difference in knowledge of science concepts favouring boys. The difference is evident in the primary grades and persists throughout the school years. In the early elementary grades, there are small differences in favour of girls in achievement in the processes of science, but these differences are erased by Grade 8. The differences which exist at Grade 12 are in favour of boys. These findings may be due to the fact that different processes were measured at different grades. Wherever knowledge of scientific concepts was necessary as a prerequisite to performance, boys outperformed girls (as in Higher Level Thinking at the Grade 8 and Grade 12 levels).

8.2.7 Differences Related to Language Background

At all grade levels, pupils who most commonly speak a language other than English at home had lower mean scores on all domains and objectives, and the statistically significant differences were usually substantial (between 4.2% and 9.7% on domain means). This group of pupils is being constantly replenished by immigration of non-English speakers to British Columbia while also being depleted by families moving to English as their most common language. When domain mean scores of those whose first language was not English are also examined, such mean scores lie between those who currently speak English at home and those who currently speak another language at home. The difference between these means and the means of those who now speak English at home decreases with increasing grade level. The overall picture is that failure to speak English at home is related to poorer performance in science. The size of the difference is reduced, and perhaps eventually erased, by increasing familarity with English acquired by learning to use it at home and by using it as the language of learning in school.

8.2.8 Other Differences

In the Grade 12 Assessment, it was found, as expected, that mean performance was closely and positively related to the amount of science taken since Grade 10 and that a sample of current Grade 10 pupils had better scores than Grade 12 pupils who had taken no science since Grade 10.

Grade 12 pupils who planned to go to university or college outperformed those who had other plans or who had not yet formulated their plans. Pupils whose plans included scientific study performed much better than those who planned further study in non-scientific areas.

8.3 Summary of Findings from the Attitude Surveys

8.3.1 Attitude Toward Science as a School Subject

At Grades 4, 8, 10, and 12 pupils consistently expressed a very positive attitude toward science in school. It was only at Grade 12, where pupils are beginning to clarify their vocational goals, where science is not a required subject and where the pupil population is thus dichotomized, that a slight increase in negative feelings toward school science was found.

No statistically significant differences were found between boys and girls in their attitude toward school science.

Interesting data were found at the Grade 10 level where pupils whose first language learned was not English and pupils whose language spoken at home was not English had more positive attitudes towards school science than the majority group.

8.3.2 Attitude Toward Scientists

At the levels assessed (Grades 8, 10 and 12) pupils expressed very positive attitudes towards scientists. In fact, the mean scores were among the highest of all the attitude scales. No sex-related differences were found within the grades.

8.3.3 Attitude Toward Science and Society

The place of science in society received the highest rating of all the attitude objects assessed. From Grade 8 to Grades 10 and 12 the mean scores increased, and the variability of scores decreased. No sex-related differences were found within grades.

8.3.4 Attitude Toward a Career in Science

Despite their positive attitude toward science in school and their expressed liking of scientists, pupils in Grades 8, 10 and 12 definitely do not have a high interest in pursuing a career in science. In fact, mean scores were the lowest obtained on the attitude scales. Sex-related differences were not significantly different within the grades. The low results are unfortunate in view of the probable increased need for scientifically talented personnel in our future work force.

8.3.5 Attitude Toward the Methods of Science

This scale assessed a variety of cognitive and affective components related to scientific knowledge, the processes of science, and the nature of scientific inquiry. Pupils in Grades 10 and 12, the only grades assessed, proved to be very knowledgeable about the aspects of science measured by the questionnaire. No sex-related differences were found within grades.

8.3.6 A Potpourri of Attitudes, Interest and Opinions

Grade 4

- About 80% of the pupils feel that the study of science in school is important
- Boys like Physical Science and Technology topics
- Girls like Biology topics

Grade 8

- Sixty-seven percent of the boys and 59% of the girls like to study science
- Sixty percent of the girls and 47% of the boys agree or are undecided as to whether or not the planets determine one's success or failure in life!
- Only 19% of the pupils would be willing to spend their life as a scientist
- Sixty percent of the pupils (males = 71%, females = 48%) are very interested in learning how to work computers

Grades 10 and 12

- Boys to a greater extent than girls claim to use scientific ideas or facts in their everyday life
- Only 18% of the pupils in Grade 10 and 21% in Grade 12 would be satisfied to spend their lives as scientists
- Boys have considerably more faith in technology than do girls
- Pupils are overwhelmingly in favour of conserving energy, but are not in favour of having highway speed limits reduced
- Pupils are equally pro, con, and undecided on supporting research related to genetic engineering

8.4 Summary of Questionnaire Findings

The following section summarizes the findings of the elementary and secondary teacher questionnaires. There will be little reiteration of data which support these findings as the information is contained in Chapters 6 and 7. The reader is thus urged to relate the highlights stated in this section to the previous documentation.

Since the 1978 Assessment, the median age of teachers from all school levels have increased by about two years. Similarly, the medians of teaching experiences have also increased by about two years. In 1982, the median experience was 10 years for both elementary and junior secondary teachers and 13 years for senior secondary teachers. British Columbia science teachers are thus an aging population and are becoming more distant in time from their pre-service training.

At the secondary levels, both in 1978 and 1982, the majority of teachers were male. Even though there was a small increase since 1978 in the number of females at the junior secondary level, nine out of ten secondary teachers in 1982 were male. At the elementary level, there was a slight increase in the number of male teachers over the four-year period, but females still comprise 62% of the teachers. At the elementary level, males are used as science specialists to a greater extent than females, consistent with their typically more extensive science backgrounds.

At all levels, the mean age of females is less than that of males. Females tend to drop out of teaching for periods of time and many return to teaching at the elementary level, but they rarely return at the secondary level. There is a failure at the secondary level both to recruit young women and to retain most of those few women who start out teaching science.

The science background of teachers in elementary schools is usually weak, particularly in the case of females. One-fourth of the elementary teachers have not taken as much as one 3-unit course in science at the university/college level. At the secondary level, the senior teachers have stronger backgrounds than the junior teachers. Junior secondary teachers are adequately prepared in the biological sciences but usually not in the physical or earth/space sciences.

One of the strong recommendations from the 1978 Science Assessment was for more coordination of science at the school and district levels. It appears now that some progress has been made in secondary schools, but not enough has been done at the district level. Half of those responding to the questionnaire indicated no district coordination. The in-school leadership situation at the elementary level remains inadequate.

In 1982, there still seems to be a lack of storage and preparation facilities and suitable classrooms for teaching elementary science. At the secondary level, facilities are inadequate in many junior schools. Provision of and inspection of safety equipment are still unacceptable at both elementary and secondary school levels. However, some improvement is noted in secondary schools since 1978.

Elementary teachers are still experiencing difficulty with equipment and materials, particularly in terms of poor quality. The situation at the secondary level has improved somewhat since 1978, but problems do remain in the small junior secondary schools. Many teachers at both the elementary and junior secondary levels find that they have to adapt their teaching because of lack of equipment.

Compared to 1978, many more teachers at all levels report that science reading materials are less than adequate, both in quality and quantity.

While elementary and junior secondary teachers see some worth in the British Columbia science program, they fall below the senior secondary teachers in their estimations of worth, even though the senior secondary teachers have significantly lowered their ratings since 1978. The elementary and junior secondary teachers' feelings of adequacy of preparation for teaching seem to be related to their perceptions.

Elementary and senior secondary teachers seem to be satisfied teaching science at their present level, but the junior secondary teachers appear to be less content with their assignment, a similar situation to that in 1978. Many of the latter expressed a desire to teach in a junior-senior secondary school.

Elementary teachers are not generally spending the recommended time in teaching science. This situation correlates highly with their lack of scientific background. At the secondary level, there is a strong trend toward increasing specialization in teaching science but such a tendency is missing at the elementary level.

Almost all senior secondary school teachers feel adequately prepared to teach science, but a small percentage of junior secondary science teachers feel unprepared, and 42% of elementary school teachers feel less than adequately prepared.

Teachers at all levels expressed common suggestions for change. The three top ranked were:

- the provision of print materials other than textbooks
- background information for teachers
- provision to help exceptional pupils, both gifted and handicapped

Other highly rated suggestions included the need for more adequate reading resources, increased use of specialist science teachers in elementary schools and the need for science programs to emphasize the impact of science on society.

Most teachers felt that their initial preparation for teaching science was inadequate. Only 30% of the teachers believed their pre-service training was adequate or better. Even among senior secondary teachers who rated their training more highly than other teachers, only 52% felt the initial training to have been adequate or better.

Given a list of teacher education topics, all teacher groups felt each component should receive greater emphasis than it actually did in their pre-service education. Particular attention is called to the large discrepancy between the emphasis which should be and the time which was given to the topic of Laboratory Safety.

Nearly 50% of all teachers surveyed expressed the need for extensive in-service education. Almost all teachers were willing to participate in release-time in-service, and a large proportion indicated they would participate after school hours. The most preferred forms of in-service are also the easiest to plan, so that it was somewhat disturbing to discover that one-third of the teachers had declared that such activities had not been planned in their districts. Teachers who had experienced in-service found these activities to be more effective in 1982 than in 1978. In view of the findings of this Assessment, in-service requirements seem to command a very high priority.

Of concern must be the lack of impact that the 1978 Science Assessment had on science education in British Columbia. Since teachers reported being unaware of the 1978 results, it is strongly suggested that districts make copies of both the Provincial Summary Report and the District Interpretation Report directly available to all science teachers.

Elementary science teachers report using a wide variety of classroom activities, with verbal interaction activities and the consideration of observations on data activities outranking hands-on manipulative activities. At the secondary level, teachers report that performing experiments from instructions and answering questions are more frequent pupil activities than is verbal interaction. Pupils designing their own experiments is the least frequent activity at all levels.

Among important elements of scientific procedure are such activities as generalizing information to new problem situations, making graphs from experimental data, and designing and doing experiments. Junior secondary teachers use these activities less often than the Contract Team views as desirable. The infrequency of these activities in the classroom may have led to some of the weaknesses in pupil performance which the results of the achievement forms and the subsequent Interpretation Panel ratings show.

As in 1978, the Contract Team agrees that secondary schools should examine ways in which to obtain more time for science instruction. In particular, disenchantment has grown with the semester system, and parallels a trend towards abandonment of such a time-table.

Since 1978, the textbook programs, STEM and Exploring Science, have become available to most British Columbia elementary teachers, and the Materials Based Program has become less available. Nearly three-fourths of the teachers use a combination of programs, with a higher proportion of primary than intermediate teachers doing so. The most commonly used materials are the Exploring Science texts, with STEM texts having second place. Forty percent of the elementary school teachers report that they lack sufficient materials to teach their program. Exploring Science is the program with which most teachers have greatest familiarity, and familiarity with the Materials Based Program has declined a great deal since 1978. Teachers prefer the programs in the following order: Exploring Science, STEM and Materials Based. Most teachers prefer the program they know best.

Teachers who are most familiar with or who prefer Exploring Science feel that it is easy to prepare for, to teach, has readable texts and is suitable to their backgrounds. Teachers who are most familiar with or who prefer STEM do so for a wide variety of reasons, none of which was selected by a preponderance of teachers. The Materials Based Program is very highly rated for its interest and relevance to pupils, the amount of pupil activity and the content selection by those teachers most familiar with or most favourable to it.

The Contract Team commends the Ministry of Education for work done so far on the Junior Secondary Program, particularly the successful introduction of a better Grade 9 program. The new Grade 9 textbook has received considerable approval from teachers. Further improvement is anticipated with the introduction of the proposed new junior secondary curriculum.

One area of concern, however, is the lack of time spent in teaching earth science.

The Biology 11 and 12 courses are causing increasing problems. Because of out-of-date or inappropriate texts, and because of course content in Biology 12 which may be too extensive for the time available, a revision of the biology curriculum may be indicated. Teachers report that the new Physics 11 course is an improvement over the old course.

8.5 Recommendations: Of Highest Priority

The Advisory Committee held two extensive discussions with the Contract Team about the significance of the findings from this Assessment and it was agreed that the area of teacher education, both in-service and pre-service, should be singled out for special consideration and priority recommendations.

Factors such as facilities, materials and equipment, curriculum and teaching-learning conditions are important in the teaching of science. However, quality in these factors is secondary in importance to the quality of the teaching force. Dedicated, competent and confident teachers are needed if science is to be taught well. Confidence and competence are related to the training one has for the job.

The Assessment found that a large number of elementary school teachers have no academic or professional courses in science or the teaching of science and, therefore, must be considered inadequately prepared. There are even larger numbers who have minimal science backgrounds and who admit that they do not feel adequately prepared. In contrast, at the secondary level, most teachers feel adequately prepared, and the data suggest that the vast majority of them have taken course work in depth in at least one science area. There is evidence, *however, that many junior secondary* teachers lack depth of background in physical and in earth/space sciences, and a small percentage lack professional courses in science teaching.

The various groups involved with the Assessment are convinced that science is more than a unique body of knowledge. They believe that there are scientific ways of obtaining knowledge and of thinking about the natural world. Central to these beliefs are methods of systematic observation and experimentation, careful presentation and interpretation of data, and evaluations of the interpretations of others. Because of these convictions, the Advisory Committee and the Contract Team set specifications for the assessment exercises which stressed science processes and critical thinking. Review Panels accepted the items in these areas as valid reflections of the goals of the British Columbia science program. The Interpretation Panels expressed most of their concerns and made most of their recommendations in these areas.

The Contract Team and the Advisory Committee interpreted the data from the achievement forms, from the Interpretation Panels' deliberations, and from the teacher questionnaires, to mean that the unique features of science are not well taught or well learned.

There was unanimous agreement among all groups involved with the Assessment that pupils must be taught in a safe environment, and must be taught safe procedures. The "Marginal" or "Weak" Interpretation Panel ratings given on the safety objective at all three levels cast doubts on the effectiveness of the teaching.

The teacher questionnaire data strongly indicate that the teachers of British Columbia are prepared to invest time and effort in improving their competence as science teachers.

When all the foregoing factors are considered, it seems necessary that there be an organized and concerted effort in British Columbia to improve the competence of those teachers now in the field and to ensure that future teachers are adequately prepared for the task which confronts them.

It is therefore recommended:

Recommendation 1.

that the Program Implementation Branch of the Ministry of Education coordinate the design, development and delivery of in-service programs for teachers which will focus on the following areas of need:

- **how to teach science processes and critical thinking skills**

- **the development of an adequate background of science knowledge in areas stressed in the curriculum, in areas of weakness for elementary teachers, and in the physical and earth/space sciences for junior secondary teachers**
- **how to safely teach science**
- **how to teach safety to pupils**

The Contract Team suggests that the provincial Science Advisory Committee guide the design and development process. For junior secondary teachers, the program should be linked to the implementation of the new curriculum. It is further suggested that, as far as possible, the delivery of these in-service programs be in forms which teachers find most helpful--informal meetings with other science teachers, workshops conducted by teachers and visits to model classrooms. One of the priority needs expressed by teachers was for background information relating to the science curriculum. Such sources of information must be accessible to teachers.

Ways to prepare and provide background information for both elementary and junior secondary teachers must be developed. Various groups, such as the B.C. Science Teachers' Association and university personnel should be consulted. The preparation of the source book for junior secondary science teachers might provide a model for this process.

* * *

Recommendation 2.

that the following actions be taken with respect to the pre-service training of teachers:

- **the Faculties of Education should revise teacher education programs as needed to ensure that:**
    - **(i) all pre-service elementary teachers experience science study to a minimum of a 3-unit course or equivalent at the university/college level, and**
    - **(ii) all pre-service elementary teachers take a course in science teaching methodology**
- **the Faculties of Education should give greater emphasis to each of the techniques and topics identified by teachers to be most inadequately emphasized in their pre-service training (See Tables 3.1 and 3.2)**

- **the Ministry of Education should revise certification guidelines to reflect the above**

8.6 Further Recommendations

Throughout this report, recommendations are made wherever the analysis of the data identifies a need. Sometimes, similar recommendations are made in different places. The following sections collect these recommendations and combine them. In addition, the text of the report often suggests or urges desirable courses of action. For brevity, these suggestions have not been reprinted in this chapter.

8.6.1 Recommendations to the Ministry of Education, Province of British Columbia

Not only must the science teachers be knowledgeable about safety in science teaching, but the conditions under which science is taught must be safe.

It is therefore recommended:

Recommendation 3.

that the Ministry of Education establish safety standards for school science classrooms, and provide funds for school districts not only to conduct surveys of the science safety equipment in schools where science is taught but also to correct deficiencies that may be discovered through such surveys. (This recommendation is repeated from the 1978 Assessment.)

* * *

A consistent theme in the secondary teachers' questionnaire was the need to re-examine the senior secondary biology program.

It is therefore recommended:

Recommendation 4.

that the Curriculum Development Branch of the Ministry of Education establish a Senior Secondary Biology Revision Committee to re-examine all aspects of the senior secondary biology curriculum.

8.6.2 Recommendations to be School Districts of British Columbia

The teacher questionnaires clearly demonstrate that science teachers feel a need for adequate science coordination at both school and district levels. Some progress has been made since 1978 but the Contract Team is of the opinion that more is necessary.

It is therefore recommended:

Recommendation 5.

that school districts:

- **evaluate the form of science coordination within each school and establish some form of school-level coordination where none now exists**
- **not currently providing science coordination appoint or designate a qualified individual or individuals to be responsible for coordination and leadership of the science programs within the district**

* * *

If science is to be well taught, there must be both adequate facilities and a good supply of necessary equipment and materials.

It is therefore recommended:

Recommendation 6.

that school districts:

- **investigate the potential for converting some existing elementary general classrooms into rooms with adequate science facilities**
- **examine elementary schools for ways to utilize available space so that central storage and preparation space is available for science teaching**
- **attempt to provide for adequate ventilation, storage space for volatiles, increased general storage space for equipment and materials, increased preparation space and increased space for storage of pupil projects where these are needed in schools**
- **examine the quantity and quality of the materials and equipment used in their science programs, and make a determined effort to effect improvements where these are necessary, especially in elementary schools and small junior secondary schools**
- **encourage school libraries to purchase an adequate supply of science reading materials in both elementary and secondary schools**

* * *

Questionnaire data show that there is a small but not insignificant proportion of junior secondary teachers who are teaching science without adequate preparation. This situation will further weaken the science program at a level where there are already serious weaknesses.

It is therefore recommended:

Recommendation 7.

- **that, wherever possible, school districts and administrators avoid assigning teachers with little science background to teach science in junior secondary grades. Where teachers must be reassigned outside their specialty, provisions should be made for retraining.**

8.6.3 Recommendations to Schools and School Administrators in British Columbia

Attention is drawn to recommendations 5, 6 and 7.

* * *

Interpretation Panels' judgements of the achievement results clearly indicates that elementary school science programs are not as effective as they should be. Questionnaire data show that a substantial percentage of British Columbia elementary school pupils receive instruction in science for less time than the Ministry of Education recommends.

It is therefore recommended:

Recommendation 8.

- **that school administrators and teachers follow the time allocations given for science instruction in the Administrative Handbook**

8.6.4 Recommendations to Teachers of Science in British Columbia

Attention is drawn to recommendation 8.

* * *

Teachers at all levels showed concern about the lack of printed information other than textbooks available for pupils in science. This item was ranked highest by all groups of teachers on a list of suggested changes. The provision of such materials is a responsibility of school districts, but the choice must involve science teachers.

It is therefore recommended:

Recommendation 9.

- **that teachers and school librarians cooperatively explore the upgrading of print materials in libraries and classrooms at both elementary and secondary levels**

* * *

A finding from the Grade 12 Assessment was that pupil achievement in earth sciences was especially weak. A finding from the secondary questionnaire was that junior secondary teachers were spending less time in these areas than in any others.

It is therefore recommended:

Recommendation 10.

- **that junior secondary teachers give greater time emphasis to earth science topics.**

* * *

The Interpretation Panels that examined the provincial data for pupil performance made a number of recommendations to teachers. All are stated in Chapters 3, 4 and 5, but some call for special emphasis in this section, and it is possible to combine certain of the recommendations.

It is therefore recommended:

Recommendation 11.

that science teachers:

- **ensure that pupils understand safe procedures appropriate to their level**
- **give pupils more practice in presenting results in symbolic forms (especially graphs) and in interpreting such forms**
- **give extensive time (particularly in elementary school) and emphasis to measurement and quantification skills and to the use of the metric system**
- **give pupils in upper elementary and secondary grades adequate experience in analyzing variables and designing controlled experiments**
- **give more emphasis to teaching the practical applications of science knowledge and to using that knowledge in new situations**

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APPENDIX A

ACKNOWLEDGEMENTS

Hundreds, in fact thousands, of individuals helped assess the status of science education in the schools of British Columbia. The Contract Team would like to thank all of them for their contributions. Certain individuals and groups need special thanks as they stand out because of their special and unique efforts. These include:

teachers and students -

without the work of hundreds of teachers and their 80,000 pupils, the assessment would not have taken place.

the Advisory Committee -

for their many hours of detailed study of questionnaires, assessment items and final reports. The names of the committee members appear elsewhere in this report.

the Review Panels and Interpretation Panels -

members of the panels helped improve the validity of the assessment and, as well, set the important standards upon which the results were judged.

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- Larry Yore who offered suggestions on the suitability of the assessment objectives

APPENDIX B

MEMBERS OF REVIEW PANELS

Primary Panels

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APPENDIX C

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Bart Deeter, Science Helping Teacher, Surrey
Peter Demchuk, Teacher, Saanich School District
Ian Johnson, Teacher, Kimberley School District
Scott Nicholson, Teacher, Burnaby School District
Ken Serl, Vice-Principal, Kamloops School District
Bill Smith, Teacher, Chilliwack School District
Marguerite Sykes, Trustee, Merritt School District
Pat Tait, Teacher, South Okanagan School District
Kathy Wade, Teacher, Langley School District
Reg Wild, University of British Columbia
Audrey Will, Parent, Vancouver
Dan Young, Teacher, Sooke School District

Grade 12

Ken Baker, Teacher, Nanaimo School District
John Betts, Camosun College
Keith Burnett, Teacher, Chilliwack School District
Bob Cocoran, Teacher, Independent School, Vancouver
Don Cunningham, Teacher, Quesnel School District
Allan Davis, Teacher, Cranbrook School District
Bob Gardner, Teacher, Burnaby School District

Marguerite Hall, Trustee, Quesnel School District
Don Jacques, Teacher, Prince George School District
Hollis Kelly, Trustee, Surrey School District
Alice Marquardt, Teacher, Peace River South School District
Elaine Murphy, Teacher, Nanaimo School District
Neil Risebrough, University of British Columbia
Lynn Sturgeon, Parent, North Vancouver

APPENDIX D

LIST OF PILOT SCHOOLS

Primary (Grade 4 Items)

A.H.P. Matthew Elementary, Surrey School District
Bear Lake Elementary, Prince George School District
Belgo Elementary, Central Okanagan School District
Birchland Elementary, Coquitlam School District
Blueridge Elementary, North Vancouver School District
Blundell Elementary, Richmond School District
Brooke Elementary, Delta School District
Brookemere Elementary, Coquitlam School District
Brennan Creek Elementary, Kamloops School District
Canyon Heights Elementary, North Vancouver School District
Cedar Hills Community, Surrey School District
Chu Chua Elementary, Kamloops School District
Coghlan Elementary, Langley School District
College Heights Elementary, Prince George School District
Cougar Canyon Elementary, Delta School District
Dr. George M. Weir Elementary, Vancouver School District
Doncaster Elementary, Victoria School District
Dorothea Walker, Central Okanagan School District
Fairburn Elementary, Victoria School District
Fort Langley Elementary, Langley School District
General Brock Elementary, Vancouver School District
General Montgomery Elementary, Surrey School District
Gray Elementary, Delta School District
Green Timbers Elementary, Surrey School District
Grosvenor Road Elementary, Surrey School District
Haldi Road Elementary, Prince George School District
Happyvale Elementary, Kamloops School District
Hawthorne Elementary, Delta School District
Hazel Trembath Elementary, Coquitlam School District
Holly Elementary, Delta School District
H.T.T. Thrift Elementary, Surrey School District
James Thompson Elementary, Richmond School District
John Errington Elementary, Richmond School District
Kitchener Elementary, Burnaby School District
Lakeview Elementary, Burnaby School District
Lincoln Elementary, Coquitlam School District
Lochdale Community, Burnaby School District
Lynn Valley Elementary, North Vancouver School District
Martin Elementary, Central Okanagan School District
McLeod Lake Elementary, Prince George School District
Meadow Elementary, Prince George School District
Moody Elementary, Coquitlam School District
Morley Elementary, Burnaby School District

Mount Pleasant Elementary, Vancouver School District
Nelson Elementary, Burnaby School District
Norgate Elementary, North Vancouver School District
North Kamloops Elementary, Kamloops School District
Northbridge Elementary, Victoria School District
Nukko Lake Elementary, Prince George School District
Pineview Elementary, Prince George School District
Prince Charles Elementary, Surrey School District
Queen Victoria Elementary, Vancouver School District
Quilchena Elementary, Vancouver School District
Richmond Elementary, Victoria School District
Rochester Elementary, Coquitlam School District
Royal Heights Elementary, Surrey School District
Shady Valley Elementary, Prince George School District
Shaughnessy Elementary, Vancouver School District
Shortreed Elementary, Langley School District
Simonds Elementary, Langley School District
Sir Alexander MacKenzie, Vancouver School District
Sir Wilfred Laurier Elementary, Vancouver School District
Sir William MacDonald, Vancouver School District
Sperling Elementary, Burnaby School District
Springvalley Elementary, Central Okanagan School District
Spruceland Elementary, Prince George School District
Sunshine Hills Elementary, Delta School District
Tecumseh Elementary, Vancouver School District
Tillicum Elementary, Victoria School District
Trafalgar Elementary, Vancouver School District
Tynehead Elementary, Surrey School District
Van Bien Elementary, Prince George School District
View Royal Elementary, Victoria School District
Westmount Elementary, Kamloops School District
Westsyde Elementary, Kamloops School District
William Bridge Elementary, Richmond School District

Intermediate (Grade 8 Items)

Alpha Secondary, Burnaby School District
Brocklehurst Junior Secondary, Kamloops School District
College Heights Secondary, Prince George School District
Dr. Knox Junior Secondary, Central Okanagan School District
Frank Hurt Secondary, Surrey School District
George Pringle Secondary, Central Okanagan School District
Gladstone Secondary, Vancouver School District
Handsworth Secondary, North Vancouver School District
Hastings Junior Secondary, Coquitlam School District
Hugh McRoberts Junior Secondary, Richmond School District
John Oliver Secondary, Vancouver School District
Kelly Road Secondary, Prince George School District
Lambrick Park Secondary, Victoria School District
S.J. Willis Junior Secondary, Victoria School District

Tsawwassen Junior Secondary, Delta School District
University Hill Secondary, Vancouver School District
Wm. Beagle Junior Secondary, Surrey School District

Secondary (Grade 10 and 12 Items)

Alpha Secondary, Burnaby School District
College Heights Secondary, Prince George School District
Frank Hurt Secondary, Surrey School District
George Pringle Secondary, Central Okanagan School District
Gladstone Secondary, Vancouver School District
Handsworth Secondary, Vancouver School District
John Oliver Secondary, Vancouver School District
Mount Douglas Senior Secondary, Victoria School District
Port Coquitlam Senior Secondary, Coquitlam School District
Steveston Senior Secondary, Richmond School District

Timing Pilot (Grade 4 Forms)

Carnarvan Elementary, Vancouver School District
Coronation Park Elementary, Coquitlam School District
K.B. Woodward Elementary, Surrey School District
Seaforth Elementary, Burnaby School District
Sir Matthew Begbie Elementary, Vancouver School District
Sir Wm. Van Horne Elementary, Vancouver School District

APPENDIX E

Form 4X

school code

British Columbia
SCIENCE ASSESSMENT
1982

Province of British Columbia
Ministry of Education
Schools Department
Programs Division
Learning Assessment Branch

BACKGROUND INFORMATION

HOW TO MARK YOUR ANSWERS

Put an X beside your answer.

For example: Do you live in Canada?

Yes..........X 1
No...........____ 2

---

1. Did you write your school code number in the boxes on the front cover? If not, please do so now.

2. When were you born?

Year: 1970 or earlier 4 1
1971.......... 32 2
1972.......... 61 3
1973 or later.. 2 4

Month: January........____ 01
February.......____ 02
March..........____ 03
April..........____ 04
May............____ 05
June...........____ 06
July...........____ 07
August.........____ 08
September......____ 09
October........____ 10
November.......____ 11
December.......____ 12

3. Are you a boy or a girl?

Boy.......... 51 1
Girl.......... 49 2

4. What language did you use when you FIRST learned to speak?

English....... 87 1
Another language...... 13 2

5. What language do you NOW speak most often at home?

English....... 93 1
Another language...... 7 2

INTEREST IN SCIENCE TOPICS

Directions: Below are listed four TOPICS IN SCIENCE. Read each one and then CIRCLE the choice which shows how interested you are in learning about that topic.

EXAMPLE:

HOW LIGHTNING WORKS.

Not Interested 1	[✓ Somewhat Interested 2]	Very Interested 3

Please be as honest as possible in rating each topic. There is no correct answer. Do not spend too much time on any one topic.

FORM 4X

1. HOW BIRDS LIVE.

Not Interested .21	Somewhat Interested .50	Very Interested .29

2. WHY THINGS RUST.

Not Interested .46	Somewhat Interested .36	Very Interested .18

3. WHY RIVERS FLOOD.

Not Interested .27	Somewhat Interested .44	Very Interested .28

4. HOW AIRPLANES FLY.

Not Interested .24	Somewhat Interested .32	Very Interested .43

FORM 4Y

1. HOW FLOWERS GROW.

Not Interested .36	Somewhat Interested .44	Very Interested .20

2. HOW MAGNETS WORK.

Not Interested .18	Somewhat Interested .42	Very Interested .39

3. WHY VOLCANOES BLOW UP.

Not Interested .13	Somewhat Interested .28	Very Interested .58

4. HOW AN ELECTRIC LIGHT WORKS.

Not Interested .24	Somewhat Interested .46	Very Interested .30

FORM 4Z

1. HOW YOUNG ANIMALS LIVE.

Not Interested .15	Somewhat Interested .43	Very Interested .42

2. WHY SOMETHING BURNS.

Not Interested .36	Somewhat Interested .43	Very Interested .20

3. WHY STARS SHINE.

Not Interested .15	Somewhat Interested .36	Very Interested .48

4. HOW A TELEVISION WORKS.

Not Interested .22	Somewhat Interested .35	Very Interested .42

SCHOOL SCIENCE

Directions: The statements below tell how some students feel about SCHOOL SCIENCE. Read each statement and then CIRCLE the choice which best describes how you feel about it.

Here is an example about skating which shows how to mark your answer if you disagree with the statement.

SKATING IS A WASTE OF TIME.

Strongly Disagree 1 [✓ Disagree 2] Can't Decide 3 Agree 4 Strongly Agree 5

Please be as honest as possible in rating each statement. There is no correct answer. Do not spend too much time on any one statement.

---

1. I LIKE TO STUDY SCIENCE IN SCHOOL.

Strongly Disagree .07 Disagree .11 Can't Decide .24 Agree .40 Strongly Agree .17

2. I FEEL THE STUDY OF SCIENCE IN SCHOOL IS IMPORTANT.

Strongly Disagree .03 Disagree .06 Can't Decide .12 Agree .46 Strongly Agree .32

3. SCIENCE IS DULL.

Strongly Disagree .29 Disagree .40 Can't Decide .15 Agree .10 Strongly Agree .06

4. I DO NOT ENJOY SCIENCE.

Strongly Disagree .27 Disagree .43 Can't Decide .15 Agree .10 Strongly Agree .06

5. I WOULD LIKE TO STUDY MORE SCIENCE.

Strongly Disagree .09 Disagree .16 Can't Decide .23 Agree .33 Strongly Agree .19

6. SCIENCE CLASSES ARE BORING.

Strongly Disagree .25 Disagree .41 Can't Decide .16 Agree .11 Strongly Agree .06

7. SCIENCE IS A VALUABLE SUBJECT.

Strongly Disagree .05 Disagree .08 Can't Decide .18 Agree .37 Strongly Agree .33

SECOND ASSESSMENT OF SCIENCE

GRADE 4 1982

Organization of Test Items

Objective		Test Items*	Page No.
	DOMAIN 1: SCIENCE PROCESSES		
1.1	Observe and Infer	X: 1,17,25,28,29,36 Y: 4,9,15,26,34,35 Z: 4,7,8,9,16,20	2-12
1.2	Classify	X: 5,6,7,9,19,31 Y: 11,18,19,25,27,33 Z: 10,13,17,21,26,35	13-23
1.3	Communicate	X: 4,12,13,24,32,33 Y: 5,6,7,23,29,31 Z: 2,3,28,31,32,33	24-34
1.4	Quantify	X: 16,22 Y: 3,13 Z: 23,24	35-36
	DOMAIN 2: KNOWLEDGE: RECALL AND UNDERSTAND		
2.1	Biological, Physical, and Earth/Space Science Concepts	X: 2,8,11,15,23,26 Y: 8,10,12,14,20,22 Z: 5,11,14,29,30,34	37-43
2.2	Applications of Science and the Nature of Science	X: 3,30 Y: 2,24 Z: 12,19	44-45
2.3	Safety Procedures	X: 14,20,35 Y: 1,21,32 Z: 1,15,25	46-48
	DOMAIN 3: HIGHER LEVEL THINKING		
3.1	Science Concepts	X: 10,18,34 Y: 28,30,36 Z: 22,27,36	49-53
3.2	Rational and Critical Thinking	X: 21,27 Y: 16,17 Z: 6,18	54-55

* X = Test Booklet X
Y = Test Booklet Y
Z = Test Booklet Z

DOMAIN 1: SCIENCE PROCESSES

OBJECTIVE 1.1: OBSERVE AND INFER

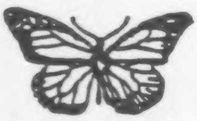
1.1.01 X/01 Which ONE of thesr will tell you most about the weight of an object?

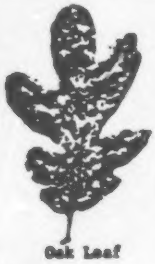
VS

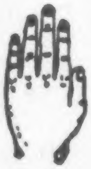
		p-value
A. Touching it	☐	3
B. Lifting it	☒	89
C. Looking at it	☐	6
D. I don't know	☐	3

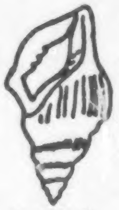
1.1.02 X/17 Which ONE PICTURE has halves which are MOST LIKE each other? (PICK ONE PICTURE ONLY.)

M


Butterfly

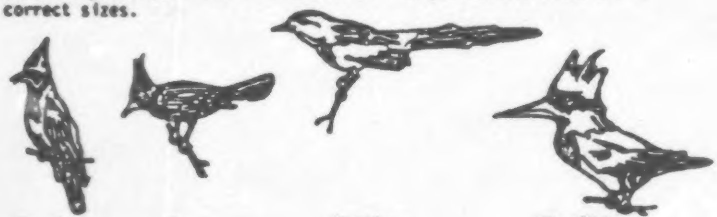

Oak Leaf


Hand


Sea Shell

		p-value
A. Butterfly	☒	50
B. Oak leaf	☐	15
C. Hand	☐	14
D. Sea shell	☐	5
E. I don't know	☐	15

Here are pictures of four common birds. The pictures are not the correct sizes.



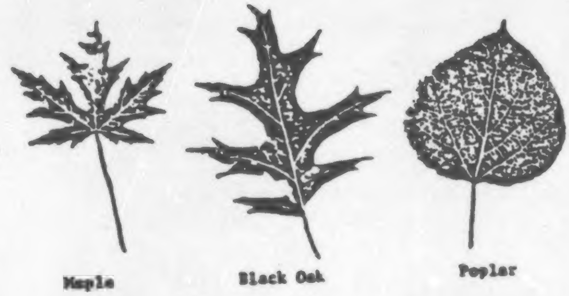
1.1.03 X/25 In these pictures, which bird has the SHORTEST tail feathers?

VS

		p-value
A. Waxwing	☐	3
B. Jay	☐	8
C. Magpie	☐	7
D. Kingfisher	☒	78
E. I don't know	☐	3

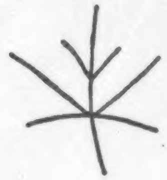
OBJECTIVE 1.1: OBSERVE AND INFER

Here are the pictures of three leaves. The lines in the leaves are called veins. Use these pictures to answer questions 28 and 29.



1.1.04 X/28 In which leaf are the main veins MOST like the pattern shown below?

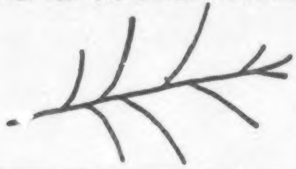
ST



		p-value
A. Maple	☒	87
B. Black Oak	☐	3
C. Poplar	☐	8
D. I don't know	☐	2

1.1.05 X/29 For which leaf are the main veins MOST like the pattern shown below?

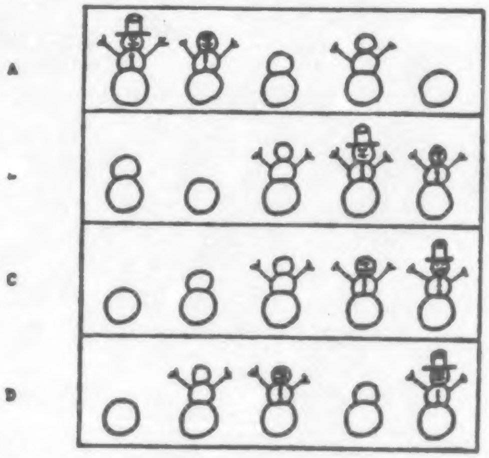
ST



		p-value
A. Maple	☐	3
B. Black Oak	☒	91
C. Poplar	☐	4
D. I don't know	☐	2

1.1.06 X/36 Which set of pictures shows the BEST way to build a snowman?

ST



		p-value
A.	☐	3
B.	☐	2
C.	☒	92
D.	☐	3
E. I don't know	☐	1

OBJECTIVE 1.1: OBSERVE AND INFER

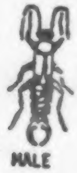
1.1.07 Y/04 Which sense does a magnifying glass help?

VS

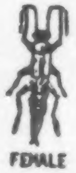
p-value

A. Sight . . . . ☒ 91
B. Touch . . . . ☐ 4
C. Smell . . . . ☐ 2
D. I don't know . . . . ☐ 4

Here are two pictures of earwigs.



MALE



FEMALE

1.1.08 Y/09 How can you tell a male earwig from a female earwig?

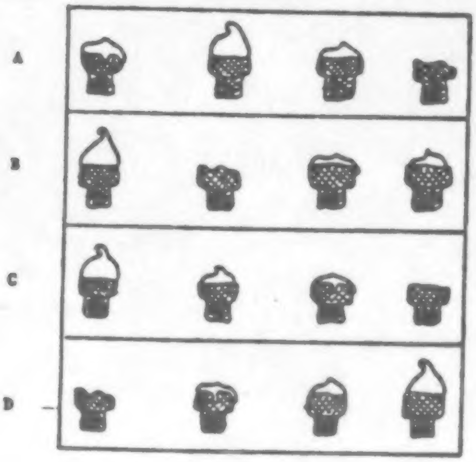
ST

p-value

A. They have different kinds of pincers at the end of their body. . . . . ☒ 89
B. Female earwigs have longer legs. . . . . ☐ 2
C. Male earwigs are larger than female earwigs. . . . . ☐ 3
D. Male earwigs are stronger. . . . . ☐ 3
E. I don't know. . . . . ☐ 3

1.1.09 Y/15 Which set of pictures BEST shows how an ice cream cone changes as you eat it?

VS

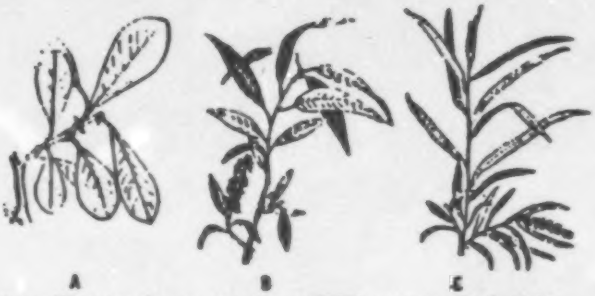


p-value

A. . . . . ☐ 3
B. . . . . ☐ 3
C. . . . . ☒ 84
D. . . . . ☐ 9
E. I don't know . . . . ☐ 1

OBJECTIVE 1.1: OBSERVE AND INFER

Here are pictures of the twigs of three willow bushes.



1.1.10 Y/26 Which willow has leaves which are WIDEST near the leaf tip?

S

p-value

A. . . . . ☒ 76
B. . . . . ☐ 10
C. . . . . ☐ 10

D. I don't know . . . . ☐ 4

1.1.11 Y/34 Three children feel an object inside a bag. They can feel and smell it, but not see it. Which child's statement is what he THINKS BUT NOT WHAT HE OBSERVES?

W

p-value

A. Mark says, "It is flat at one end and round at the other". . . . . ☐ 22
B. Bob says, "It smells like peppermint candy". . . . . ☐ 29
C. John says, "It is a tube of glue". ☒ 28

D. I don't know. . . . . ☐ 21

1.1.12 Y/35 Lisa wants to know what ants eat. What should she do?

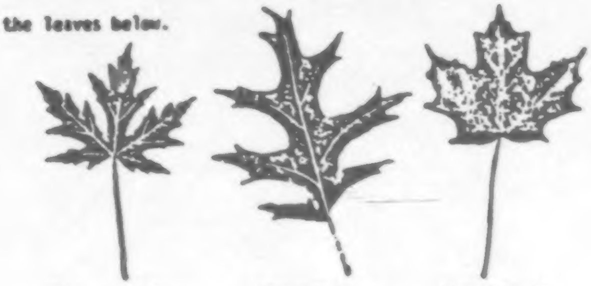
VS

p-value

A. Compare the shape of the queen ant to the other ants. . . . . ☐ 4
B. Measure the length of the ants. . . . . ☐ 4
C. Find the kinds of places ants go when they leave
the anthill. . . . . ☒ 78

D. I don't know. . . . . ☐ 13

Look at the leaves below.



1.1.13 Z/04 Which leaf has the most points?

S

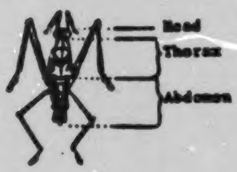
p-value

A. Silver Maple . . . . ☒ 73
B. Black Oak . . . . ☐ 18
C. Sugar Maple . . . . ☐ 4

D. I don't know . . . . ☐ 4

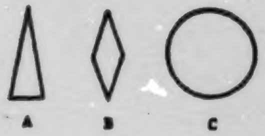
OBJECTIVE 1.1: OBSERVE AND INFER

Here is a picture of an insect called a WATER STRIDER. Its body is made of three parts: head, thorax and abdomen. Use this picture to answer questions 7 and 8.



1.1.14 Z/07 Which shape below is MOST like the shape of its body?

VS



p-value

A. . . . . ☐ 10
B. . . . . ☒ 85
C. . . . . ☐ 3
D. I don't know . . . . ☐ 2

1.1.15 Z/08 Look at the picture of the water strider again. The thorax is

M

p-value

A. about as long as the abdomen. . . . . . . ☒ 54
B. much longer than the abdomen. . . . . . . ☐ 9
C. much shorter than the abdomen. . . . . . ☐ 26
D. I don't know. . . . . ☐ 11

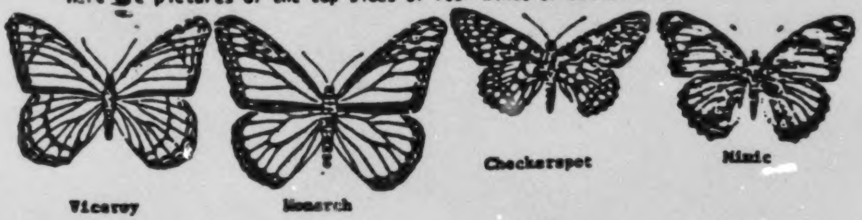
1.1.16 Z/09 Which sense does a thermometer help?

W

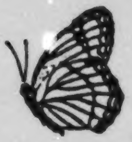
p-value

A. Touch . . . . ☒ 31
B. Sight . . . . ☐ 32
C. Taste . . . . ☐ 14
D. I don't know . . . . ☐ 23

Here are pictures of the top sides of four kinds of butterflies.



Here is a side view of one of them.



1.1.17 Z/16 What kind of butterfly is shown in the side view?

VS

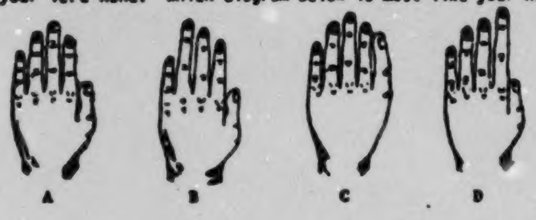
p-value

A. Viceroy . . . . ☒ 78
B. Monarch . . . . ☐ 10
C. Checkerspot . . . . ☐ 2
D. Mimic . . . . ☐ 6
E. I don't know . . . . ☐ 4

OBJECTIVE 1.1: OBSERVE AND INFER

1.1.18 Z/20 Look at your left hand. Which diagram below is most like your hand?

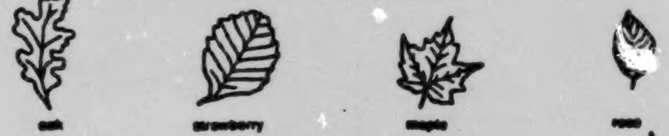
VS



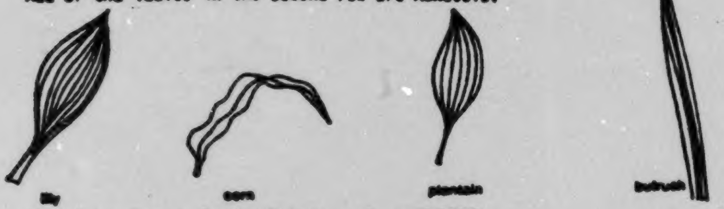
		p-value
A.	☒	88
B.	☐	3
C.	☐	5
D.	☐	1
E. I don't know	☐	3

OBJECTIVE 1.2: CLASSIFY

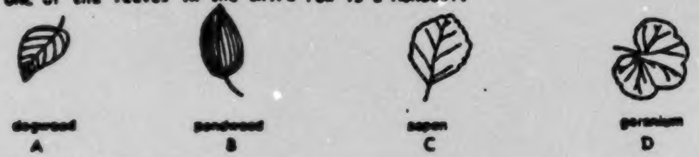
ALL of the leaves in the first row are DICOTS.


oak
strawberry
maple
rose

ALL of the leaves in the second row are MONOCOTS.


lily
corn
plantain
bulrush

ONE of the leaves in the third row is a MONOCOT.


dogwood
A
pondweed
B
aspen
C
geranium
D

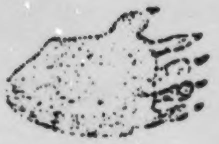
1.2.01 X/05 Which leaf is a MONOCOT?

M

		p-value
A.	☐	6
B.	☒	51
C.	☐	10
D.	☐	8
E. I don't know	☐	25

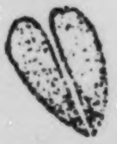
OBJECTIVE 1.2: CLASSIFY

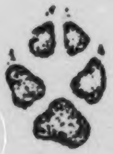
Here is a picture of a track made by an animal foot

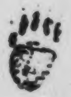


1.2.02 X/06 Which ONE of these tracks was made by an animal with the same number of toes?

VS


A


B


C

		p-value
A.	☐	2
B.	☐	9
C.	☒	83
D. I don't know	☐	4

Look at the chart below.

	TRIANGLES	SQUARES
RED	A	B
BLUE	C	D

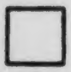
1.2.03 X/07 In which space would you put a blue square?

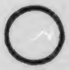
M

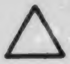
		p-value
A.	☐	1
B.	☐	9
C.	☐	20
D.	☒	59
E. I don't know	☐	10

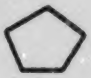
1.2.04 X/09 Which shape does NOT belong with the others?

W


A


B


C


D

		p-value
A.	☐	1
B.	☒	48
C.	☐	2
D.	☐	46
E. I don't know	☐	3

Sam put the names of animals into two groups.

Group I	Group II
cow horse deer squirrel	dog cat wolf cougar

1.2.05 X/19 Why did he make these groups this way?

S

		p-value
A. One group lives on farms; the other lives wild in the forest.	☐	14
B. One group climbs trees; the other does not.	☐	6
C. One group eats only plants; the other eats mostly meats.	☒	69
D. I don't know.	☐	11

OBJECTIVE 1.2: CLASSIFY

Here are two groups of animals.

Group I	Group II
spider	frog
slug	snake
earthworm	robin
moth	cat

1.2.06 X/31 To which group would a bee belong?

S

p-value

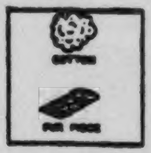
A. Group I . . . . ☒ 67

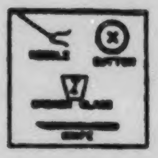
B. Group II . . . . ☐ 8

C. Neither . . . . ☐ 21

D. I don't know . . . . ☐ 5

A teacher arranged six objects as shown in the pictures below.





1.2.07 Y/11 Why were the objects arranged this way?

M

p-value

A. The teacher wanted to show the difference between metal and non-metal objects. . . . . ☐ 26

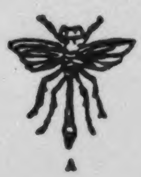
B. The teacher did not want the children to hurt themselves. . . . . ☐ 11

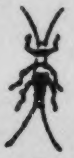
C. The teacher wanted to find out whether there were more soft objects or hard objects. . . . . ☒ 51

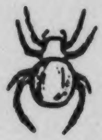
D. I don't know . . . . ☐ 11

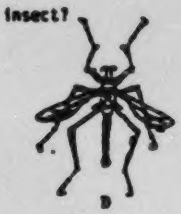
1.2.08 Y/18 Insects have six legs. Which picture below is NOT an insect?

VS


A


B


C


D

p-value

A. . . . . ☐ 4

B. . . . . ☐ 6

C. . . . . ☒ 80

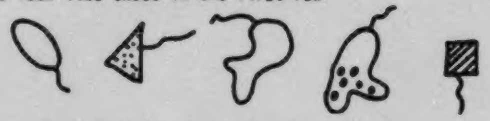
D. . . . . ☐ 5

E. I don't know . . . . ☐ 5

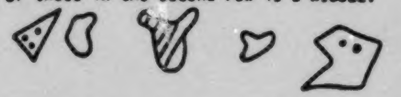
OBJECTIVE 1.2: CLASSIFY

Look at the imaginary tiny animals below.

WIBBLES look like those in the first row

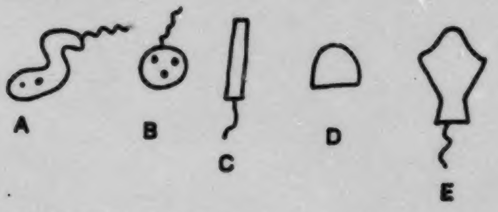


but NONE of those in the second row is a WIBBLE.



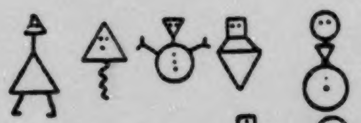
1.2.09 Y/19 Which ONE in the third row is NOT a WIBBLE?

M

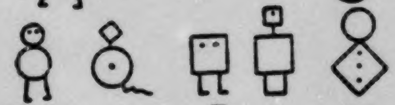


		p-value
A.	☐	6
B.	☐	3
C.	☐	13
D.	☒	58
E.	☐	5
F. I don't know	☐	15

ALL of these are NEWTS.

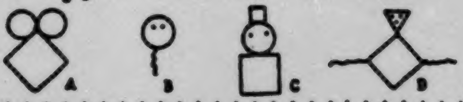


NONE of these is a NEWT.



1.2.10 Y/25 Which ONE of these is a NEWT?

S



		p-value
A.	☐	10
B.	☐	17
C.	☐	12
D.	☒	45
E. I don't know	☐	17

Look at the chart below.

	LAND ANIMALS	WATER ANIMALS
HAS BONES	A	B
DOES NOT HAVE BONES	C	D

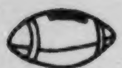
1.2.11 Y/27 In which square would you put a whale?

S

		p-value
A.	☐	5
B.	☒	72
C.	☐	2
D.	☐	16
E. I don't know	☐	5

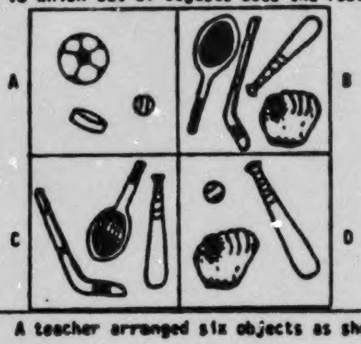
OBJECTIVE 1.2: CLASSIFY

Here is a football.



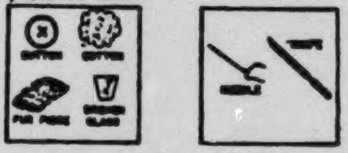
1.2.12 T/33 To which set of objects does the football belong?

ST



		p-value
A.	☒	88
B.	☐	2
C.	☐	1
D.	☐	3
E. I don't know	☐	6

A teacher arranged six objects as shown in the pictures below.



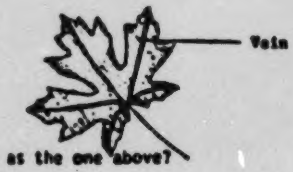
1.2.13 Z/10 Why were the objects arranged this way?

S

		p-value
A. The teacher wanted to show the difference between metal and non-metal objects.	☒	57
B. The teacher did not want the children to hurt themselves.	☐	9
C. The teacher wanted to find out whether there were more soft objects or hard objects.	☐	25
D. I don't know.	☐	10

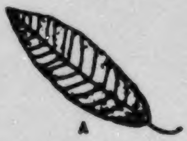
Here is a picture of a leaf.

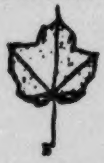
The lines on the leaf are called veins.

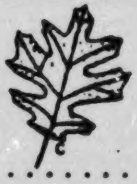


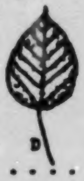
1.2.14 Z/13 Which of these leaves has the SAME pattern of veins as the one above?

VS


A


B


C


D

		p-value
A.	☐	1
B.	☒	85
C.	☐	9
D.	☐	1
E. I don't know	☐	1

All of these are felines.	None of these is a feline.
Lion	Wolf
Cougar	Bear
Cat	Cow
Cheetah	Bat

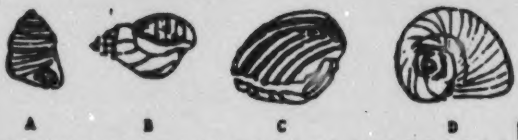
1.2.15 Z/17 Which one of the following is a feline?

VS

		p-value
A. Dog	☐	7
B. Seal	☐	3
C. Beaver	☐	2
D. Tiger	☒	75
E. I don't know	☐	12

OBJECTIVE 1.2: CLASSIFY

1.2.16 Z/21 Which seashell does NOT belong with the others?



VS

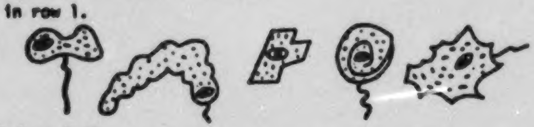
p-value

A. . . . . ☐ 7
B. . . . . ☐ 4
C. . . . . ☒ 70
D. . . . . ☐ 15

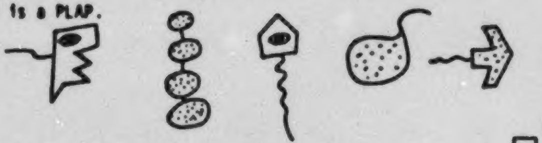
E. I don't know . . . . ☐ 4

Look at the pictures of imaginary pond water animals.

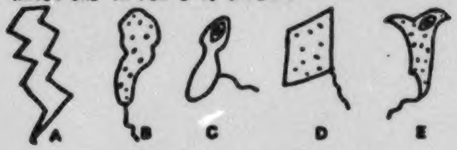
PLAPS look like all those in row 1.



But NONE of those in row 2 is a PLAP.



1.2.17 Z/26 Which ONE in row 3 is a PLAP?



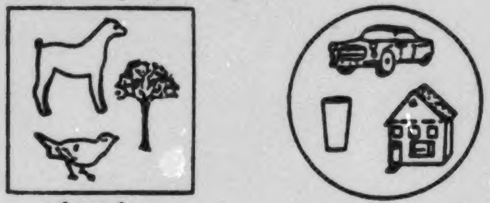
M

p-value

A. . . . . ☐ 6
B. . . . . ☐ 14
C. . . . . ☐ 16
D. . . . . ☐ 5
E. . . . . ☒ 41

F. I don't know . . . . . ☐ 18

Here are pictures of two groups of objects.

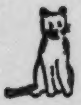


Group I

Group II

1.2.18 Z/35 To which group does the cat belong?

S



p-value

A. Group I . . . . ☒ 78
B. Group II . . . . ☐ 8
C. Neither . . . . ☐ 12

D. I don't know . . . . ☐ 2

OBJECTIVE 1.3: COMMUNICATE

1.3.01 X/04 You are going to do an experiment about rusting. Which ONE of the following should you do FIRST?

W

p-value

A. Put a piece of steel wool into each jar. . . . . ☐ 14
B. Put the cap on one jar. Put two teaspoons of water into the other jar. . . . . ☐ 13
C. Get two jars with lids. Make sure they are completely dry. . . . . ☒ 35
D. Look at both jars each day for five days. Record what you see. . . . . ☐ 10

E. I don't know . . . . ☐ 27

OBJECTIVE 1.3: COMMUNICATE

This chart shows a record of some kinds of birds which were seen in a park in Prince George from January to June in one year. Use it to answer questions 12 and 13.

	Gray Jay	Robin	Snow Bunting	Snow Goose	Humming Bird	Herring Gull
January	✓		✓			
February	✓		✓			
March	✓					
April	✓	✓		✓	✓	✓
May	✓	✓			✓	✓
June	✓	✓			✓	✓

1.3.02 X/12 Which kind of bird was seen in ONLY ONE MONTH?

VS

p-value

A. Snow Bunting . . . . ☐ 4
B. Snow Goose . . . . ☒ 82
C. Humming Bird . . . . ☐ 3
D. Robin . . . . ☐ 4

E. I don't know . . . . ☐ 7

1.3.03 X/13 In which month was ONLY ONE KIND of bird seen?

M

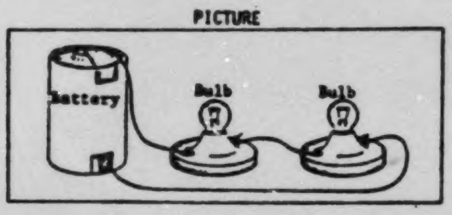
p-value

A. March . . . . ☒ 41
B. April . . . . ☐ 48
C. May . . . . ☐ 2
D. June . . . . ☐ 3

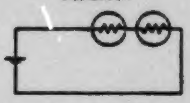
E. I don't know . . . . ☐ 7

Look at the picture and diagram of the picture below.

PICTURE



DIAGRAM



1.3.04 X/24 What does the symbol ┼ in the diagram mean?

M

p-value

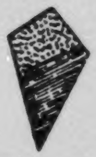
A. A light . . . . ☐ 16
B. A twisted wire . . . . ☐ 16
C. A piece of tape . . . . ☐ 4
D. A battery . . . . ☒ 35

E. I don't know . . . . ☐ 28

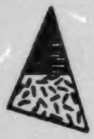
OBJECTIVE 1.3: COMMUNICATE

1.3.05 X/32 A Traw is a triangle with a black border and it is shaded into two parts. Which of the following is a Traw?

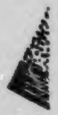
W



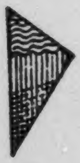
A



B



C



D

p-value

A. . . . . ☐ 17

B. . . . . ☒ 40

C. . . . . ☐ 15

D. . . . . ☐ 10

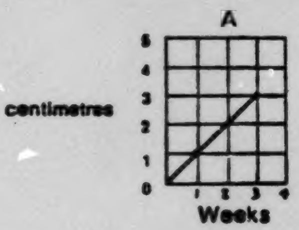
E. I don't know . . . . ☐ 17

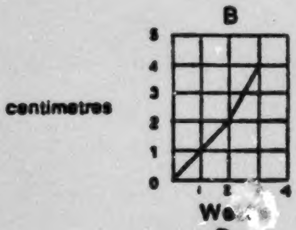
A plant grows this way

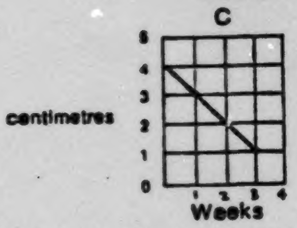
The first week it is 1 centimetre high.
The second week it is 2 centimetres high.
The third week it is 4 centimetres high.

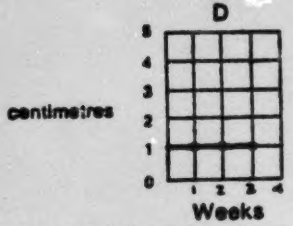
1.3.06 X/33 Which of the following graphs shows this growth?

M









p-value

A. . . . . ☐ 14

B. . . . . ☒ 47

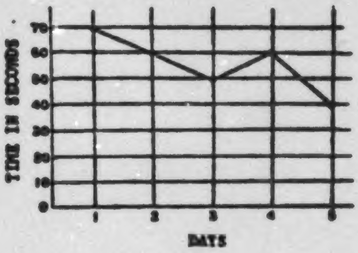
C. . . . . ☐ 11

D. . . . . ☐ 10

E. I don't know . . . . ☐ 18

OBJECTIVE 1.3: COMMUNICATE

Blast O'Wind is a race horse that runs around a track each day. The graph below shows the time it took Blast O'Wind to run around the track each day. Use this graph to answer questions 5 and 6.



1.3.07 Y/05 How many seconds did it take Blast O'Wind to run around the track on Day 2?

S

p-value

A. 50 seconds . . . . ☐ 8

B. 60 seconds . . . . ☒ 67

C. 70 seconds . . . . ☐ 15

D. I don't know . . . . ☐ 9

1.3.08 Y/06 What was the ONE day in which Blast O'Wind ran around the track in exactly 40 seconds?

S

p-value

A. Day 1 . . . . ☐ 9

B. Day 3 . . . . ☐ 9

C. Day 5 . . . . ☒ 73

D. I don't know . . . . ☐ 9

1.3.09 Y/07 Which of the following tells you MOST about the LIFE of a house fly?

M

p-value

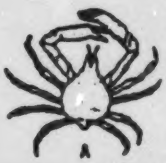
A. The bodies of adult flies are made of three parts. The middle has the legs and wings. . . . . ☐ 15

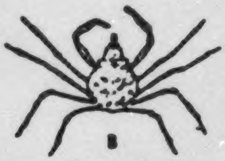
B. Adult flies are pests. Sometimes they carry diseases to humans. . . . . ☐ 14

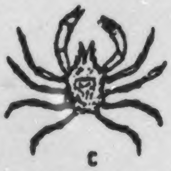
C. Adult flies lay eggs, which hatch into maggots. Large maggots become pupae. Finally, pupae become adult flies. . . . . ☒ 54

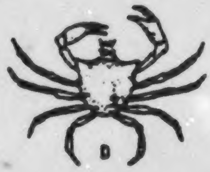
D. I don't know . . . . ☐ 18

A Sharp-Nosed Crab has a body shaped like a pear, with the pointed end toward the front. It has no sharp corners on its body. Its claws and legs are quite thick.


A


B


C


D

1.3.10 Y/23 Which ONE of these is a Sharp-Nosed Crab?

M

p-value

A. . . . . ☒ 50

B. . . . . ☐ 30

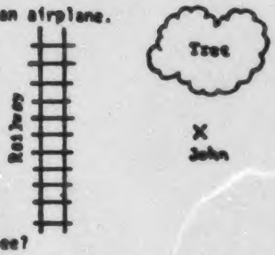
C. . . . . ☐ 6

D. . . . . ☐ 10

E. I don't know . . . . ☐ 4

OBJECTIVE 1.3: COMMUNICATE

In the diagram below, you are looking down from an airplane.



1.3.11 Y/29 The railway is on John's right. Where is the tree? p-value

M

A. Behind John . . . . ☒ 40
B. In front of John . . . . ☐ 43
C. On John's left . . . . ☐ 13
D. I don't know . . . . ☐ 4

The following chart shows the temperature measured at different times on three days. Use this chart to answer question 31.

	6:00 am	9:00 am	Noon	3:00 pm	6:00 pm
MONDAY	15°C	17°C	20°C	21°C	19°C
TUESDAY	15°C	15°C	15°C	10°C	9°C
WEDNESDAY	8°C	10°C	14°C	14°C	13°C

1.3.12 Y/31 When was the highest temperature recorded? p-value

S

A. 6:00 pm on Wednesday . . . . ☐ 7
B. Noon on Monday . . . . ☐ 14
C. 3:00 pm on Monday . . . . ☒ 67
D. Noon on Tuesday . . . . ☐ 4
E. I don't know . . . . ☐ 9

Here is a chart from a school nurse's record book. Use it to answer questions 2 and 3.

Name	Age (years)	Height (cm)	Mass (kg)
Jane	9	120	35
Kathy	8	115	26
Leo	10	132	35
Mark	9	110	24
Norma	9	124	30
Olga	10	140	33

1.3.13 Z/02 How tall is Norma? p-value

ST

A. 110 cm . . . . ☐ 2
B. 124 cm . . . . ☒ 93
C. 140 cm . . . . ☐ 2
D. I don't know . . . . ☐ 2

1.3.14 Z/03 Which child has the smallest mass? p-value

VS

A. Kathy . . . . ☐ 6
B. Norma . . . . ☐ 1
C. Mark . . . . ☒ 87
D. Jane . . . . ☐ 4
E. I don't know . . . . ☐ 2

OBJECTIVE 1.3: COMMUNICATE

A class decided to show the temperature with the following shapes:

Circle ○ for over 20°C

Diamond ◇ for 10° to 20°C

Triangle △ for 5° to 10°C

On each of three days the temperature at noon was:

Monday	Tuesday	Wednesday
23°C	22°C	12°C

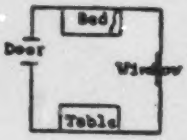
1.3.15 Z/28 Which of the following shows the temperatures at noon for the three days?

W

Mon.	Tues.	Wed.			p-value
○	◇	△	A.	☐	20
○	○	△	B.	☐	10
○	○	◇	C.	☒	27
◇	◇	△	D.	☐	7
			E. I don't know	☐	35

1.3.16 Z/31 A girl enters a room. There is a bed along the wall to her LEFT, a window in the wall in FRONT of her and a table along the wall to her RIGHT. Which of the rooms below did she enter?

M


Bed
Door
Window
Table

A

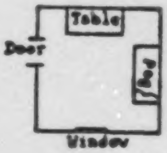


Table
Door
Bed
Window

B

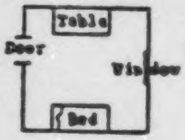
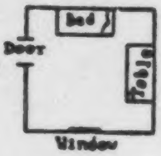


Table
Door
Window
Bed

C

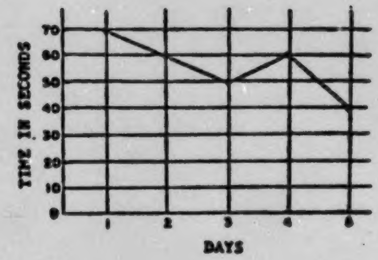

Bed
Door
Table
Window

D

		p-value
A.	☒	58
B.	☐	9
C.	☐	12
D.	☐	15
E. I don't know	☐	6

OBJECTIVE 1.3: COMMUNICATE

Blast O'Wind is a race horse that runs around a track each day. The graph below shows the time it took Blast O'Wind to run around the track each day. Use this graph to answer questions 32 and 33.



1.3.17 Z/32 What number is missing in the table below?

VS

Day	Seconds
1	70
2	60
3	
4	60
5	40

		p-value
A. 40	☐	4
B. 50	☒	84
C. 60	☐	4
D. I don't know	☐	8

1.3.18 Z/33 Look at the graph again. On which day did Blast O'Wind run the SLOWEST?

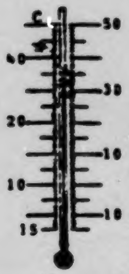
MS

		p-value
A. Day 1	☒	25
B. Day 2	☐	5
C. Day 5	☐	59
D. I don't know	☐	10

OBJECTIVE 1.4: QUANTIFY

1.4.01 X/16 What temperature does this thermometer show?

M



		p-value
A. 30°C	☐	7
B. 34°C	☒	46
C. 35°C	☐	36
D. 40°C	☐	6
E. I don't know	☐	5

1.4.02 X/22 You could measure how heavy you are in

M

		p-value
A. kilograms.	☒	65
B. litres.	☐	6
C. kilometres.	☐	7
D. millilitres.	☐	8
E. I don't know.	☐	15

1.4.03 Y/03 Which would be easiest to measure with a metric ruler that is 30 cm long?

M

		p-value
A. The length of a pencil	☒	65
B. The thickness of a sheet of paper	☐	13
C. The distance from your home to the school	☐	3
D. The distance from your home to the nearest grocery store	☐	2
E. I don't know	☐	17

OBJECTIVE 1.4: QUANTIFY

1.4.04 Y/13 If you want to find out how much a person grew in one year, which of the following MUST you know about the person?

S

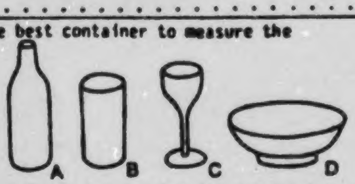
p-value

A. His age . . . . ☐ 14
B. The type of food he eats . . . . ☐ 9
C. His height at the start of the year . . . . ☒ 69
D. The height of his mother and father . . . . ☐ 3

E. I don't know . . . . ☐ 5

1.4.05 Z/23 Which one of those shown below is the best container to measure the amount of rainfall in millimetres?

M



p-value

A. . . . . ☐ 26
B. . . . . ☒ 40
C. . . . . ☐ 6
D. . . . . ☐ 21

E. I don't know . . . . ☐ 8

1.4.06 Z/24 You could measure the distance from your home to the school in

S

p-value

A. dozens. . . . . ☐ 4
B. metres. . . . . ☒ 79
C. grams. . . . . ☐ 5
D. litres. . . . . ☐ 5

E. I don't know. . . . . ☐ 8

DOMAIN 2: KNOWLEDGE: RECALL AND UNDERSTAND

OBJECTIVE 2.1: BIOLOGICAL, PHYSICAL, AND EARTH/SPACE SCIENCE CONCEPTS

p-value

2.1.01 X/02 Each year the Earth moves once around

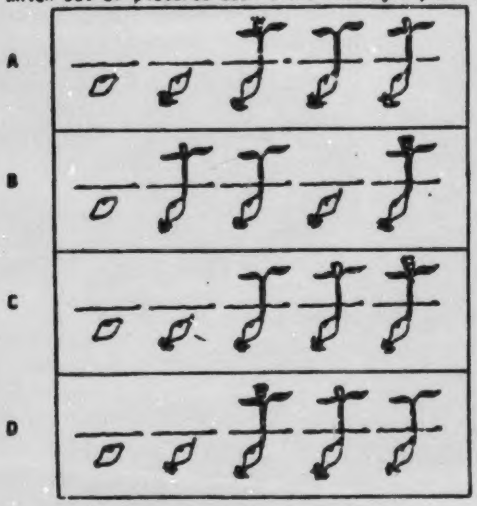
M

A. Mars. . . . . ☐ 2
B. Saturn. . . . . ☐ 2
C. the Sun. . . . . ☒ 63
D. the Moon. . . . . ☐ 11
E. all of the other planets. ☐ 7

F. I don't know. . . . . ☐ 15

2.1.02 X/08 Which set of pictures BEST shows the way a plant grows?

VS



p-value

A. . . . . ☐ 6
B. . . . . ☐ 3
C. . . . . ☒ 83
D. . . . . ☐ 7

E. I don't know . . . . . ☐ 2

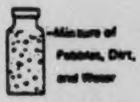
OBJECTIVE 2.1: BIOLOGICAL, PHYSICAL, AND EARTH/SPACE SCIENCE CONCEPTS

2.1.03 X/11 Where does the Earth get MOST of its energy?

S

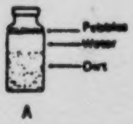
		p-value
A. Electricity	☐	20
B. The Sun	☒	66
C. The wind	☐	7
D. I don't know	☐	8

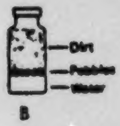
Arthur put water in a jar. Then he added spoonfuls of pebbles and dirt until the jar was nearly full. He covered the jar and shook it. It then looked like this:

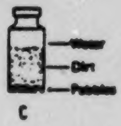

Mixture of
Pebbles, Dirt,
and Water

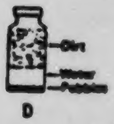
2.1.04 X/15 If he let the jar stand covered without shaking it for a week, the jar would look most like which of these pictures?

S


Pebbles
Water
Dirt
A


Dirt
Pebbles
Water
B


Water
Dirt
Pebbles
C


Dirt
Water
Pebbles
D

		p-value
A.	☐	8
B.	☐	7
C.	☒	68
D.	☐	13
E. I don't know	☐	5

2.1.05 X/23 Which of the following dissolves LEAST in water?

M

		p-value
A. Glass	☒	49
B. Salt	☐	18
C. Soap	☐	13
D. Sugar	☐	11
E. I don't know	☐	9

2.1.06 X/26 Germs sometimes make people sick because germs

M

		p-value
A. make poisons.	☒	33
B. keep the blood from moving.	☐	17
C. use up all of the water in the body.	☐	21
D. don't like people and want to hurt them.	☐	7
E. I don't know.	☐	21

2.1.07 Y/08 In many parts of British Columbia, a noon temperature of 2°C is most likely in

M

		p-value
A. January.	☒	47
B. May.	☐	13
C. June.	☐	10
D. July.	☐	12
E. I don't know.	☐	19

OBJECTIVE 2.1: BIOLOGICAL, PHYSICAL, AND EARTH/SPACE SCIENCE CONCEPTS

2.1.08 Y/10 You hold a sponge under water and squeeze it. Bubbles come to the top. What are the bubbles made of?

M

		p-value
A. Air	☒	50
B. Soap	☐	18
C. Water vapour	☐	16
D. Sponge gas	☐	8
E. I don't know	☐	7

2.1.09 Y/12 Where does the baby chick get its food before it hatches?

M

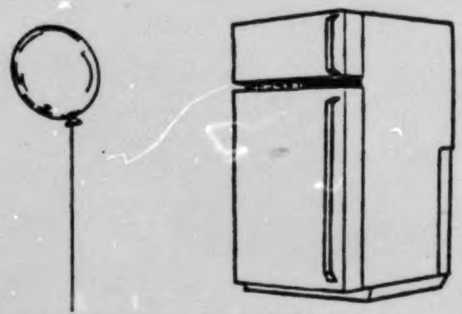
		p-value
A. The food is stored in the egg.	☒	46
B. The baby chick makes its own food.	☐	6
C. The baby chick doesn't need any food.	☐	16
D. The mother hen feeds the baby chick.	☐	21
E. I don't know.	☐	11

2.1.10 Y/14 Seeds come from which one of the following parts of a plant?

M

		p-value
A. Flower	☒	51
B. Leaf	☐	5
C. Root	☐	30
D. Stem	☐	8
E. I don't know	☐	6

Look at the picture below.

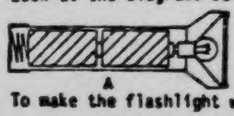


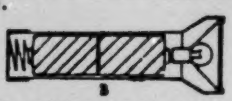
2.1.11 Y/20 What will happen to the balloon if it is left in the refrigerator?

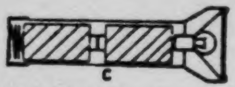
S

		p-value
A. The balloon will crack.	☐	20
B. The balloon will get bigger.	☐	5
C. The balloon will stay the same.	☐	10
D. The balloon will get smaller.	☒	54
E. I don't know.	☐	10

Look at the diagrams below.


A


B


C

2.1.12 Y/22 To make the flashlight work, which way must we place the batteries?

S

		p-value
A.	☒	59
B.	☐	22
C.	☐	12
D. I don't know	☐	6

OBJECTIVE 2.1: BIOLOGICAL, PHYSICAL, AND EARTH/SPACE SCIENCE CONCEPTS

2.1.13 Z/05 What is the MOST important thing that the lungs do?

S

			p-value
A.	Hold the chest out	☐	1
B.	Protect against germs	☐	3
C.	Move different parts of the body	☐	2
D.	Pump the blood through the body	☐	20
E.	Provide a place for oxygen to enter the blood	☒	60
F.	I don't know	☐	14

2.1.14 Z/11 What is the climate like in the desert?

VS

			p-value
A.	Hot days, cold nights, rainy	☐	4
B.	Cold days, cold nights, very dry	☐	4
C.	Hot days, cold nights, very dry	☒	75
D.	Warm days, warm nights, very rainy	☐	10
E.	I don't know	☐	8

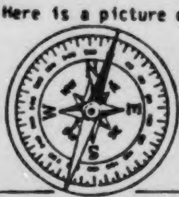
2.1.15 Z/14 Which of the following have probably been on earth the shortest time?

M

			p-value
A.	Alligators	☐	12
B.	Dragonflies	☐	14
C.	Fish	☐	7
D.	Men	☒	41
E.	Snails	☐	12
F.	I don't know	☐	14

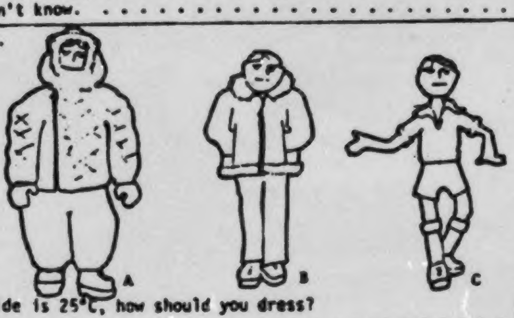
2.1.16 Z/29 Here is a picture of a compass. How does this kind of compass work?

M



			p-value
A.	The needle is affected by magnotism.	☒	51
B.	The wind blows the needle.	☐	8
C.	The needle likes to point north.	☐	8
D.	The earth's spinning makes the needle spin.	☐	21
E.	I don't know.	☐	13

Look at the pictures below.



2.1.17 Z/30 When the temperature outside is 25°C, how should you dress?

W

			p-value
A.		☐	19
B.		☐	42
C.		☒	32
D.	I don't know	☐	7

2.1.18 Z/34 Why are the rocks and pebbles found in river beds usually smooth?

S

			p-value
A.	Rivers only flow where rocks are smooth.	☐	14
B.	The rocks rubbed against other rocks.	☒	60
C.	Animals in the river keep rubbing against the rocks.	☐	12
D.	I don't know	☐	14

OBJECTIVE 2.2: APPLICATIONS OF SCIENCE AND THE NATURE OF SCIENCE

2.2.01 X/03 What part of a plant do we eat when we eat carrots?

M

p-value

A. Seeds ☐ 17
B. Stems ☐ 23
C. Roots ☒ 49
D. I don't know ☐ 11

2.2.02 X/30 How do scientists test ideas to see if they are true or not true?

S

p-value

A. Vote on the ideas. ☐ 3
B. Experiment. ☒ 76
C. Ask other scientists. ☐ 4
D. Read a book. ☐ 7
E. I don't know. ☐ 10

2.2.03 Y/02 Where does leather come from?

VS

p-value

A. Skins of animals ☒ 86
B. Mined from the earth ☐ 2
C. Bark of trees ☐ 4
D. I don't know ☐ 7

2.2.04 Y/24 What does an astronomer study?

S

p-value

A. Electricity and magnetism ☐ 8
B. Animals and plants ☐ 4
C. Stars and planets ☒ 67
D. Building roads and bridges ☐ 3
E. I don't know ☐ 18

2.2.05 Z/12 Some cities and towns put chlorine into their drinking water. Why do they do this?

S

p-value

A. To remove dirt from the water ☐ 26
B. To kill harmful bacteria ☒ 50
C. To make the water taste better ☐ 6
D. To make teeth tough ☐ 3
E. I don't know ☐ 15

2.2.06 Z/19 A scientist wants to study the water in a lake. Which of these will he likely do at the START of the study?

VS

p-value

A. Report that the lake is polluted ☐ 14
B. Ask people if they think the lake is pretty ☐ 6
C. Take the temperatures in the lake ☒ 72
D. I don't know ☐ 8

OBJECTIVE 2.3: SAFETY PROCEDURES

2.3.01 X/14 Why is drain cleaner (drano or lye) DANGEROUS?

W

p-value

A. It destroys skin and clothes. . . . . ☒ 37
B. It explodes easily. . . . . ☐ 22
C. It causes fire and smoke. . . . . ☐ 14
D. I don't know . . . . ☐ 26

2.3.02 X/20 What is the WORST thing you could do if your clothes caught fire?

W

p-value

A. Wrap a coat or blanket around yourself. . . . . ☐ 19
B. Roll on the floor. . . . . ☐ 22
C. Run for help. . . . . ☒ 44
D. Put water on your clothes. . . . . ☐ 13
E. I don't know. . . . . ☐ 2

2.3.03 X/35 Why is gasoline DANGEROUS?

S

p-value

A. It explodes easily. . . . . ☒ 83
B. It stains your skin. . . . . ☐ 6
C. It destroys metals. . . . . ☐ 2
D. It makes holes in clothing. . . . . ☐ 4
E. I don't know. . . . . ☐ 6

2.3.04 Y/01 You need to move a piece of metal but think it might be very hot. How can you find out safely?

W

p-value

A. Touch it with the tip of your finger. . . . . ☐ 9
B. Bring the back of your hand up close to it. . . . . ☒ 37
C. Splash water on it. . . . . ☐ 46
D. I don't know. . . . . ☐ 8

2.3.05 Y/21 During science class, you drop a glass jar and break it. There is glass all over the floor. What should you do?

S

p-value

A. Try to pick up the pieces yourself. ☐ 4
B. Throw the broken pieces into the wastepaper basket. . . . . ☐ 6
C. Do not touch the glass, but tell the teacher right away. . . . . ☒ 80
D. Brush up the glass with a paper towel. . . . . ☐ 6
E. I don't know. . . . . ☐ 3

2.3.06 Y/32 Which of these should you NOT do on a field trip?

S

p-value

A. Go exploring alone . . . . ☒ 86
B. Talk to your friends about what you see . . . . ☐ 2
C. Dress properly for the trip . . . . ☐ 4
D. Write down important things you see . . . . ☐ 3
E. I don't know . . . . ☐ 4

2.3.07 Z/01 When riding your bicycle at night, you should wear white clothing because

ST

p-value

A. it warms better than dark clothing. ☐ 2
B. it reflects light better than dark clothing. . . . . ☒ 94
C. it cools better than dark clothing. ☐ 2
D. I don't know. . . . . ☐ 2

OBJECTIVE 2.3: SAFETY PROCEDURES

2.3.08 Z/15 Your teacher did some experiments. He left a little bottle, which has some lumps of pretty blue stuff in it, on his desk. What should you do?

VS

p-value

A. Only look at it. . . . . ☒ 88

B. Try to touch the lumps. . . . . ☐ 6

C. Taste the lumps. . . . . ☐ 1

D. I don't know. . . . . ☐ 5

2.3.09 Z/25 What is the MOST likely injury you could get from a classroom animal, such as a gerbil or guinea pig?

M

p-value

A. A sting . . . . ☐ 3

B. A disease . . . . ☐ 16

C. A kick . . . . ☐ 4

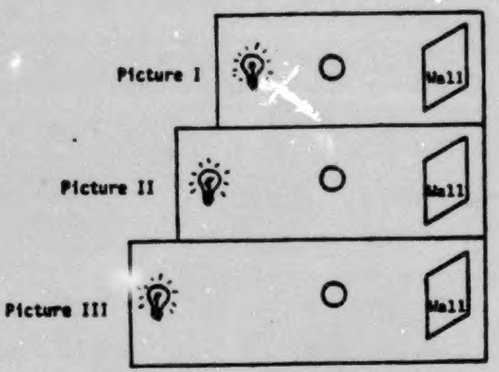
D. A bite . . . . ☒ 70

E. I don't know . . . . ☐ 7

DOMAIN 3: HIGHER LEVEL THINKING

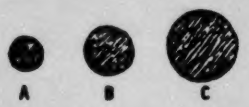
OBJECTIVE 3.1: SCIENCE CONCEPTS

Here are three pictures in which a small light makes a shadow of a ball on a wall. The balls are all the same size.



3.1.01 X/10 Here are pictures of the three shadows. Which shadow belongs to Picture III?

S



p-value

A. . . . . ☒ 49

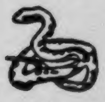
B. . . . . ☐ 8

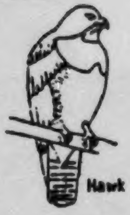
C. . . . . ☐ 33

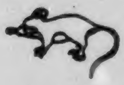
D. I don't know . . . . ☐ 9

OBJECTIVE 3.1: SCIENCE CONCEPTS

Look at the pictures below.


Garden Snake


Hawk


Mouse

Grain

3.1.02 X/18 In what order should they be to show a food chain? *p-value*

W

A. Grain-Mouse-Snake-Hawk . . . . ☒ 37

B. Grain-Snake-Hawk-Mouse . . . . ☐ 5

C. Hawk-Snake-Grain-Mouse . . . . ☐ 14

D. Snake-Hawk-Mouse-Grain . . . . ☐ 30

E. I don't know . . . . ☐ 13

3.1.03 X/34 If the moon moved further away from the earth, it would look *p-value*

ST

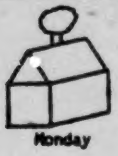
A. the same. . . . . ☐ 4

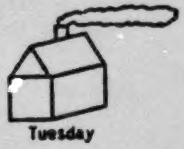
B. larger. . . . . ☐ 6

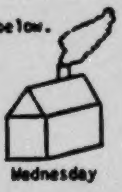
C. smaller. . . . . ☒ 85

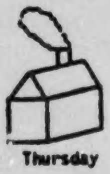
D. I don't know. . . . . ☐ 5

Look at the smoke from the chimneys below.


Monday


Tuesday


Wednesday


Thursday

3.1.04 Y/28 On which day was the wind STRONGEST? *p-value*

ST

A. Monday . . . . ☐ 1

B. Tuesday . . . . ☒ 94

C. Wednesday . . . . ☐ 3

D. Thursday . . . . ☐ 1

E. I don't know . . . . ☐ 1

The following chart shows the temperature measured at different times on three days. Use this chart to answer question 30.

	6:00 am	9:00 am	Noon	3:00 pm	6:00 pm
MONDAY	15°C	17°C	20°C	21°C	19°C
TUESDAY	15°C	15°C	15°C	10°C	9°C
WEDNESDAY	8°C	10°C	14°C	14°C	13°C

3.1.05 Y/30 What was needed to get the information for this chart? *p-value*

S

A. Ruler and a clock . . . . ☐ 4

B. Ruler and a thermometer . . . . ☐ 15

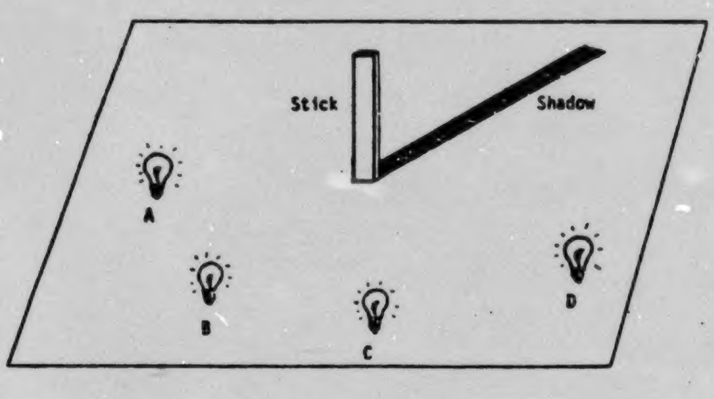
C. Barometer and a clock . . . . ☐ 7

D. Thermometer and a clock . . . . ☒ 58

E. I don't know . . . . ☐ 16

OBJECTIVE 3.1: SCIENCE CONCEPTS

The picture below shows a stick standing up on a piece of paper and light coming from four different places.



3.1.06 Y/36 Which light bulb would make the shadow shown in the picture?

M

p-value

A. . . . . ☐ 21
B. . . . . ☒ 44
C. . . . . ☐ 10
D. . . . . ☐ 18

E. I don't know . . . . ☐ 6

3.1.07 Z/22 An iron ball has a temperature of 150°C. What will happen if you put a few drops of water on it?

M

p-value

A. The water will not change. . . . . ☐ 12
B. The water will freeze. . . . . ☐ 15
C. The water will boil. . . . . ☒ 50
D. The iron will melt. . . . . ☐ 7

E. I don't know. . . . . ☐ 15

3.1.08 Z/27 Which would be true if the earth turned more slowly than it does now?

S

p-value

A. Years would be longer. . . . . ☐ 32
B. Daytime and nightime would be longer. . . . . ☒ 52
C. Daytime and nightime would not be changed. . . . . ☐ 5
D. Daytime and nightime would be shorter. . . . . ☐ 5

E. I don't know. . . . . ☐ 6

3.1.09 Z/36 A healthy green plant in a pot of good soil is kept in a room with NO LIGHT. It is carefully watered. What will the plant probably be like in a few weeks?

M

p-value

A. Healthy and green, with flowers on it . . . . ☐ 16
B. Growing slowly . . . . ☐ 14
C. Very healthy with darker green leaves than before . . . . ☐ 13
D. Dead or nearly dead . . . . ☒ 47

E. I don't know . . . . ☐ 9

OBJECTIVE 3.2: RATIONAL AND CRITICAL THINKING

3.2.01 X/21 In 1980 Mt. Saint Helens blew up. What is the BEST explanation for this happening?

S

		p-value
A. The mountain was angry.	☐	2
B. Pressures became great inside the mountain.	☒	67
C. Scientists will never explain it, because things like volcanos cannot be explained.	☐	22
D. I don't know.	☐	9

3.2.02 X/27 A scientist counts 855 tree rings on a tree stump and says the tree is about 855 years old. What does he believe about tree growth?

S

		p-value
A. There have been no forest fires for 855 years.	☐	10
B. All tree rings have the same thickness.	☐	4
C. Trees always grow one ring each year.	☒	61
D. All trees have rings..	☐	13
E. I don't know	☐	11

Read the following and then answer questions 16 and 17.

> Trash causes problems. It pollutes air, water, and soil. Trash can harm people by making them sick. Sometimes, rats live in trash.
>
> Cleaning up litter costs a lot of money. Cities and provinces have to hire people to pick up trash after games and picnics. If people make too much trash in years to come, what will happen? What can people do about it right away?

3.2.03 Y/16 The person who wrote this probably

VS

		p-value
A. litters a lot.	☐	4
B. was concerned about garbage.	☒	79
C. likes rats.	☐	2
D. wanted to make money.	☐	8
E. I don't know.	☐	7

3.2.04 Y/17 The person who wrote this probably wants

S

		p-value
A. bigger garbage dumps made.	☐	8
B. more people hired to pick up garbage.	☐	19
C. people to make less garbage.	☒	65
D. someone to kill rats.	☐	3
E. I don't know.	☐	5

3.2.05 Z/06 You wish to convince someone that animals have some way to protect themselves. Which ONE of the following would you use?

VS

		p-value
A. Cats have sharp claws and teeth.	☒	87
B. Squirrels live in forests.	☐	3
C. Frogs make a lot of noise.	☐	1
D. Cows eat grass.	☐	2
E. I don't know.	☐	7

3.2.06 Z/18 Mary blew up a balloon and rubbed it against the wall of her room. When she took her hand away, the balloon stayed on the wall without falling. Mary's friends who saw this said the following things about the balloon. Which is the MOST scientific?

VS

		p-value
A. I do not believe the balloon stayed up.	☐	6
B. The balloon wanted to stay on the wall and not fall down.	☐	5
C. I cannot explain it, but there must be a reason why it stays up.	☒	71
D. It is a magic trick and cannot be explained.	☐	9
E. I don't know.	☐	8

APPENDIX F

Form 8X

school code
☐☐☐☐☐

British Columbia
SCIENCE ASSESSMENT 1982

BACKGROUND INFORMATION

HOW TO MARK YOUR ANSWERS

Put an X beside your answer.

For example: Do you live in Canada?

Yes.......... X 1

No..........____ 2

---

1. Did you write your school code number in the boxes on the front cover? If not, please do so now.

2. What is your date of birth?

Year: 1966 or earlier 6 1

1967.......... 33 2

1968.......... 58 3

1969 or later.. 3 4

Month: January........____ 01

February......____ 02

March..........____ 03

April..........____ 04

May............____ 05

June...........____ 06

July...........____ 07

August.........____ 08

September......____ 09

October........____ 10

November.......____ 11

December.......____ 12

3. Sex: Male..........____ 1

Female.........____ 2

4. What language did you use when you FIRST learned to speak?

English........ 86 1

Another language....... 12 2

5. What language do you NOW speak most often at home?

English........ 94 1

Another language....... 5 2

6. In Grade 4 were you attending a school

in this school district?.......... 72 1

elsewhere in British Columbia?.......... 17 2

in another province in Canada?......... 8 3

outside Canada?.... 3 4

7. Have you successfully completed, or are you now taking Science 8?

Have successfully completed.......... 13 1

Am now taking...... 85 2

Have not yet taken. 1 3

Go to Page 3

8. How is or was your Science 8 course given?

Full 10-month course............. 62 1

Semester course.... 28 2

Quarter system course............. 6 3

Other............... 2 4

INTEREST IN SCIENCE TOPICS

Directions: Below are listed some TOPICS IN SCIENCE. Read each one and then CIRCLE the choice which shows how interested you are in learning about that topic.

EXAMPLE:

HOW LIGHTNING WORKS.

Not Interested 1   [✓ Somewhat Interested 2]   Very Interested 3

Please be as honest as possible in rating each topic. There is no correct answer. Do not spend too much time on any topic.

FORM 8X

---

1. DIFFERENT DISEASES PEOPLE HAVE.

Not Interested .21   Somewhat Interested .61   Very Interested .18

2. ELECTRIC POWER PRODUCTION.

Not Interested .40   Somewhat Interested .47   Very Interested .13

3. SOLAR ENERGY.

Not Interested .23   Somewhat Interested .53   Very Interested .24

4. HOW PAPER, CANS AND BOTTLES ARE RECYCLED.

Not Interested .58   Somewhat Interested .35   Very Interested .07

5. HOW TO DISSECT ANIMALS.

Not Interested .29   Somewhat Interested .36   Very Interested .3[illegible]

6. HOW SOUND COMES FROM TAPES.

Not Interested .22   Somewhat Interested .47   Very Interested .31

7. WHY VOLCANOES ERUPT.

Not Interested .21   Somewhat Interested .56   Very Interested .22

8. HOW ROCKETS WORK.

Not Interested .37   Somewhat Interested .39   Very Interested .24

9. CONTROL OF PLANT DESTROYING INSECTS.

Not Interested .52   Somewhat Interested .39   Very Interested .09

10. CHEMICALS IN FOOD.

Not Interested .30   Somewhat Interested .47   Very Interested .23

11. PLANETS.

Not Interested .21   Somewhat Interested .46   Very Interested .33

12. HOW TO WORK COMPUTERS.

Not Interested .10   Somewhat Interested .30   Very Interested .59

SCIENTISTS (8X)

---

1. SCIENTISTS ARE USUALLY ODD COMPARED WITH MOST OTHER PEOPLE I KNOW.

Strongly Disagree .11   Disagree .50   Can't Decide .23   Agree .13   Strongly Agree .02

2. SCIENTISTS USUALLY DON'T GO ALONG WITH THINGS ORDINARY PEOPLE LIKE TO DO.

Strongly Disagree .10   Disagree .46   Can't Decide .19   Agree .20   Strongly Agree .04

3. SCIENTISTS HAVE THE ANSWERS TO MOST OF THE PROBLEMS OF OUR SOCIETY.

Strongly Disagree .07   Disagree .29   Can't Decide .19   Agree .40   Strongly Agree .06

4. SCIENTISTS PUT A HIGH VALUE ON HUMAN LIFE.

Strongly Disagree .02   Disagree .08   Can't Decide .31   Agree .44   Strongly Agree .13

5. SCIENTISTS ARE PROBABLY RIGHT WHEN THEY SAY THAT THE PLANETS DO NOT DETERMINE SUCCESS AND FAILURE IN OUR DAILY LIVES.

Strongly Disagree .04   Disagree .14   Can't Decide .37   Agree .32   Strongly Agree .13

6. SCIENTISTS HAVE DONE MORE HARM THAN GOOD IN THIS WORLD.

Strongly Disagree .35   Disagree .43   Can't Decide .12   Agree .06   Strongly Agree .04

7. SCIENTISTS ARE HIGHLY INTELLIGENT.

Strongly Disagree .02   Disagree .09   Can't Decide .14   Agree .54   Strongly Agree .21

(CONT'D) SCIENTISTS (8X)

8. SCIENTISTS HAVE BEEN VERY HELPFUL TO MANKIND.

Strongly Disagree .01 Disagree .03 Can't Decide .09 Agree .61 Strongly Agree .25

9. MORE SCIENTISTS ARE URGENTLY NEEDED IN OUR SOCIETY.

Strongly Disagree .02 Disagree .16 Can't Decide .40 Agree .33 Strongly Agree .09

10. SCIENTISTS ARE NARROW MINDED PEOPLE.

Strongly Disagree .21 Disagree .47 Can't Decide .24 Agree .05 Strongly Agree .02

SCHOOL SCIENCE

Directions: The statements below tell how some students feel about SCHOOL SCIENCE. Read each statement and then CIRCLE the choice which best describes how you feel about it.

Here is an example about skating which shows how to mark your answer if you disagree with the statement.

SKATING IS A WASTE OF TIME.

Strongly Disagree 1 [✓ Disagree 2] Can't Decide 3 Agree 4 Strongly Agree 5

Please be as honest as possible in rating each statement. There is no correct answer. Do not spend too much time on any one statement.

FORM 8Y

1. I LIKE TO STUDY SCIENCE IN SCHOOL.

Strongly Disagree .04 Disagree .19 Can't Decide .19 Agree .49 Strongly Agree .09

2. I FEEL THE STUDY OF SCIENCE IN SCHOOL IS IMPORTANT.

Strongly Disagree .03 Disagree .09 Can't Decide .11 Agree .59 Strongly Agree .18

3. SCIENCE IS DULL.

Strongly Disagree .13 Disagree .50 Can't Decide .14 Agree .16 Strongly Agree .06

4. I DO NOT ENJOY SCIENCE.

Strongly Disagree .15 Disagree .49 Can't Decide .17 Agree .14 Strongly Agree .05

5. I WOULD LIKE TO STUDY MORE SCIENCE.

Strongly Disagree .08 Disagree .28 Can't Decide .27 Agree .30 Strongly Agree .07

6. SCIENCE CLASSES ARE BORING.

Strongly Disagree .12 Disagree .45 Can't Decide .20 Agree .17 Strongly Agree .07

7. SCIENCE IS A VALUABLE SUBJECT.

Strongly Disagree .03 Disagree .11 Can't Decide .14 Agree .56 Strongly Agree .17

8. TOO MANY HOURS IN SCHOOL ARE DEVOTED TO SCIENCE.

Strongly Disagree .11 Disagree .63 Can't Decide .16 Agree .08 Strongly Agree .02

9. SCIENCE SHOULD BE REQUIRED EVERY SCHOOL YEAR.

Strongly Disagree .06 Disagree .27 Can't Decide .17 Agree .38 Strongly Agree .11

10. WHAT ONE LEARNS IN SCIENCE IS USEFUL OUTSIDE OF SCHOOL.

Strongly Disagree .03 Disagree .09 Can't Decide .16 Agree .54 Strongly Agree .17

SCIENCE AND SOCIETY (8Y)

1. SCIENTIFIC PROGRESS AND THE PROGRESS OF MAN GO TOGETHER.

Strongly Disagree .07 Disagree .11 Can't Decide .24 Agree .54 Strongly Agree .09

2. SCIENTIFIC RESEARCH SHOULD NOT GET ANY OF THE TAXPAYERS' MONEY.

Strongly Disagree .11 Disagree .40 Can't Decide .22 Agree .18 Strongly Agree .08

3. IN EVERYDAY LIFE SCIENCE IS NOT AS PRACTICAL AS COMMON SENSE.

Strongly Disagree .04 Disagree .24 Can't Decide .35 Agree .32 Strongly Agree .05

4. SCIENCE IS IMPORTANT IN OUR LIVES.

Strongly Disagree .03 Disagree .10 Can't Decide .13 Agree .59 Strongly Agree .15

(CONT'D) SCIENCE AND SOCIETY (8Y)

5. SCIENCE IS NOT NECESSARY TO SOCIETY.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.21	.54	.16	.08	.01

6. SCIENTIFIC INVENTIONS AND DISCOVERIES HAVE DONE MORE GOOD THAN HARM FOR MANKIND.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.05	.09	.22	.43	.21

7. SCIENCE IS NOT IMPORTANT IN EVERYDAY LIFE.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.13	.49	.15	.19	.03

8. SCIENCE HAS CONTRIBUTED GREATLY TO THE ADVANCEMENT OF CIVILIZATION.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.01	.03	.10	.51	.34

9. THE PRODUCTS OF SCIENTIFIC WORK ARE MAINLY USEFUL TO SCIENTISTS BUT ARE NOT USEFUL TO THE AVERAGE PERSON.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.10	.44	.17	.24	.03

10. SCIENCE WILL HAVE A TREMENDOUS EFFECT ON OUR LIVES IN THE FUTURE.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.02	.05	.14	.46	.32

11. SCIENCE EXISTS FOR THE BENEFIT OF MANKIND.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.01	.07	.23	.56	.11

12. I USE SCIENTIFIC IDEAS OR FACTS IN MY EVERYDAY LIFE.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.08	.29	.21	.37	.03

SPECIFIC ISSUES (8 Z)

1. STUDENTS SHOULD LEARN HOW TO USE COMPUTERS.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.01	.08	.11	.57	.24

2. SCIENTISTS SHOULD DO MORE RESEARCH ABOUT CREATING LIFE IN THE LABORATORY.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.03	.19	.36	.36	.06

(CONT'D) SPECIFIC ISSUES (8Z)

3. ELECTRICAL GENERATORS POWERED BY COAL AND OIL CAUSE LESS POLLUTION THAN NUCLEAR PLANTS.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.07	.26	.29	.30	.07

4. HIGHWAY SPEED LIMITS SHOULD BE MADE LOWER SO THAT WE CAN SAVE GASOLINE.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.14	.46	.13	.22	.06

5. SCIENTISTS SHOULD CONDUCT EXPERIMENTS ON ANIMALS IF THEY THINK PEOPLE WILL BE HELPED.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.11	.16	.15	.45	.14

6. WE CAN USE ALL THE NATURAL GAS, OIL AND GASOLINE WE NEED NOW BECAUSE FUTURE GENERATIONS WILL FIND NEW FORMS OF ENERGY.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.26	.46	.12	.13	.02

7. WE SHOULD GET BACK TO A SIMPLER WAY OF LIFE BY GETTING RID OF ALL THIS TECHNOLOGY.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.23	.42	.18	.13	.05

8. FACTORIES SHOULD BE REQUIRED TO REDUCE SMOKE POLLUTION EVEN IF PRICES GO UP.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.03	.07	.13	.46	.30

9. PEOPLE SHOULD BE MORE CRITICAL OF COMPANIES' CLAIMS THAT THEIR MEDICAL DRUGS ARE SAFE.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.02	.06	.24	.49	.19

10. FARMERS AND RANCHERS SHOULD BE ABLE TO USE ANY CHEMICAL SPRAYS THEY THINK ARE NECESSARY.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.31	.47	.08	.11	.03

CAREERS IN SCIENCE (8Z)

1. GOING INTO SCIENCE AS A CAREER WOULD BE WELL WORTH THE TIME AND EFFORT REQUIRED.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.03	.16	.23	.47	.10

2. A CAREER IN SCIENCE WOULD BE IDEALLY SUITED TO GIRLS.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.08	.30	.29	.26	.06

(CONT'D) CAREERS IN SCIENCE (82)

3. A CAREER IN SCIENCE WOULD BE VERY SATISFYING.

Strongly Disagree .03 Disagree .20 Can't Decide .28 Agree .42 Strongly Agree .06

4. A SCIENTIFIC CAREER MIGHT BE ALL RIGHT FOR SOME PEOPLE BUT NOT FOR ME.

Strongly Disagree .07 Disagree .20 Can't Decide .16 Agree .37 Strongly Agree .19

5. SCIENCE AS A CAREER WOULD NOT INTEREST ME BECAUSE WORK IS TOO HARD.

Strongly Disagree .16 Disagree .62 Can't Decide .09 Agree .09 Strongly Agree .03

6. SCIENTIFIC WORK DOES NOT INTEREST ME.

Strongly Disagree .13 Disagree .43 Can't Decide .10 Agree .24 Strongly Agree .09

7. WORKING AS A SCIENTIST WOULD BE A DESIRABLE OCCUPATION.

Strongly Disagree .05 Disagree .26 Can't Decide .30 Agree .33 Strongly Agree .05

[illegible]. A CAREER IN SCIENCE WOULD BE IDEALLY SUITED TO BOYS.

Strongly Disagree .08 Disagree .27 Can't Decide .26 Agree .32 Strongly Agree .07

9. I WOULD BE WILLING TO TAKE A JOB RELATED TO SCIENTIFIC WORK.

Strongly Disagree .06 Disagree .28 Can't Decide .23 Agree .37 Strongly Agree .06

10. SCIENCE WOULD BE TERRIBLE AS A LIFE'S CAREER.

Strongly Disagree .15 Disagree .48 Can't Decide .18 Agree .14 Strongly Agree .06

11. I WOULD BE SATISFIED TO SPEND MY LIFE AS A SCIENTIST.

Strongly Disagree .13 Disagree .42 Can't Decide .23 Agree .17 Strongly Agree .03

12. SCIENCE WORK WOULD GIVE A GREAT DEAL OF PLEASURE.

Strongly Disagree .07 Disagree .29 Can't Decide .29 Agree .31 Strongly Agree .04

13. IT IS SILLY FOR GIRLS TO WASTE TIME STUDYING FOR A SCIENTIFIC CAREER.

Strongly Disagree .37 Disagree .46 Can't Decide .09 Agree .05 Strongly Agree .02

SECOND ASSESSMENT OF SCIENCE

GRADE 8 1982

Organization of Test Items

Objective		Test Items*	Page No.
	DOMAIN 1: SCIENCE PROCESSES		
1.1	Classify	X: 9,24,29 Y: 27,29,34 Z: 10,15,20	2-10
1.2	Communicate	X: 14,36,38 Y: 11,15,40 Z: 5,6,22	11-17
1.3	Interpret Data	X: 4,5,26 Y: 8,22,24 Z: 4,19,32	18-22
1.4	Identify and Control Variables	X: 6,7,16 Y: 4,5,6 Z: 21,30,31	23-26
	DOMAIN 2: KNOWLEDGE: RECALL AND UNDERSTAND		
2.1	Biological, Physical and Earth/Space Science Concepts	X: 1,10,11,15,17,19, 21,31,34,35,37 Y: 1,2,13,18,23,25, 26,28,30,33,39 Z: 3,11,14,16,18,23, 26,33,35,36,40	27-38
2.2	Applications of Science and the Nature of Science	X: 8,12,22,30 Y: 16,31,35,36 Z: 7,17,28,39	39-43
2.3	Safety Procedures	X: 3,18,28,39 Y: 7,10,14,20 Z: 1,13,27,34	44-47
	DOMAIN 3: HIGHER LEVEL THINKING		
3.1	Apply Biological, Physical and Earth/Space Science Concepts	X: 2,13,25,33,40 Y: 3,9,12,32,37 Z: 2,9,24,25,29	48-54
3.2	Use Rational and Critical Thinking	X: 20,23,27,32 Y: 17,19,21,38 Z: 8,12,37,38	55-60

* X = Test Booklet X
Y = Test Booklet Y
Z = Test Booklet Z

DOMAIN 1: SCIENCE PROCESSES

OBJECTIVE 1.1: CLASSIFY

The following is an identification key for eight students in a class. Use this key, step by step, to find the name of the blue-eyed blond girl.

Step 1.	Sex-boy Sex-girl	Go to Step 2 Go to Step 5
Step 2.	Eyes Blue Eyes Brown	Go to Step 3 Go to Step 4
Step 3	Hair Blond Hair Dark	Leslie Lynn
Step 4.	Hair Blond Hair Dark	Nicky Bobby
Step 5.	Eyes Blue Eyes Brown	Go to Step 6 Go to Step 7
Step 6.	Hair Blond Hair Dark	Pat Beverly
Step 7.	Hair Blond Hair Dark	Terry Lee

1.1.01 X/09 What is the name of the blue-eyed, blond girl?

S

p-value

A. Pat . . . . ☒ 68

B. Lee . . . . ☐ 1

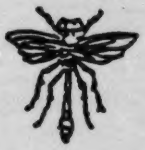
C. Leslie . . . . ☐ 21

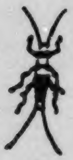
D. Terry . . . . ☐ 4

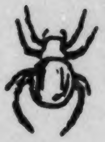
E. I don't know . . . . ☐ 5

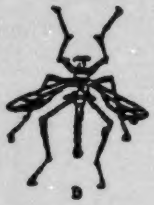
1.1.02 X/24 Insects have six legs. Which picture below is NOT an insect?

VS


A


B


C


D

p-value

A. . . . . ☐ 2

B. . . . . ☐ 6

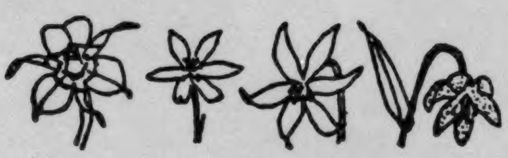
C. . . . . ☒ 86

D. . . . . ☐ 4

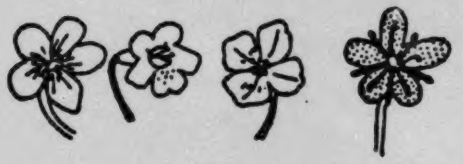
E. I don't know . . . . ☐ 2

OBJECTIVE 1.1: CLASSIFY

ALL of these are lilies.

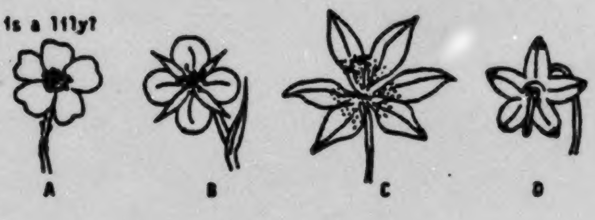


NONE of these is a lily.



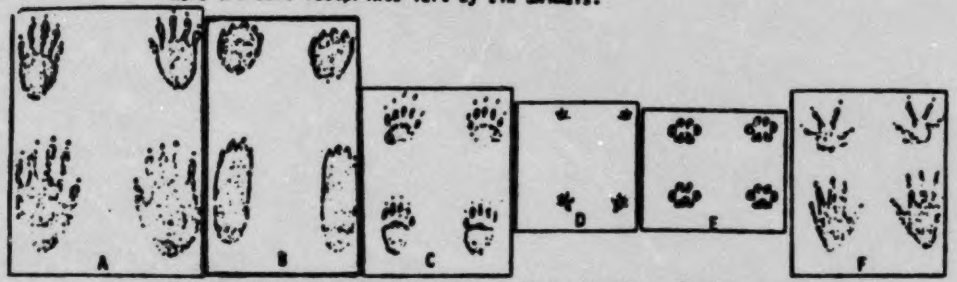
1.1.03 X/29 Which ONE of these is a lily?

M



		p-value
A.	☐	4
B.	☐	9
C.	☒	57
D.	☐	21
E. I don't know	☐	9

Here are some footprints left by six animals.



Use the identification key below to find out which animal leaves tracks LIKE PICTURE B.

Step 1.	all feet leave claw marks not all feet leave claw marks	Go to Step 2 Go to Step 4
Step 2.	entire foot leaves a print not the entire foot leaves a print	Go to Step 3 Striped Skunk
Step 3.	large prints tiny prints	Raccoon Deer Mouse
Step 4.	entire foot leaves a print not the entire foot leaves a print	Go to Step 5 House Cat
Step 5.	front feet leave claw marks front feet do not leave claw marks	Muskrat Cottontail Rabbit

1.1.04 Y/27 Which animal leaves tracks like Picture B?

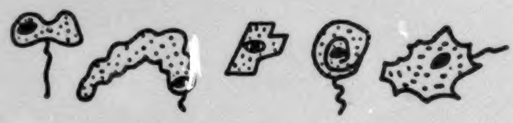
S

		p-value
A. Cottontail rabbit	☒	50
B. Striped skunk	☐	9
C. Raccoon	☐	23
D. Deer mouse	☐	4
E. I don't know	☐	13

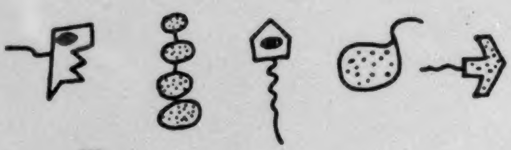
OBJECTIVE 1.1: CLASSIFY

Look at these pictures of imaginary pond water animals.

ALL of these are PLAPS:

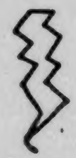


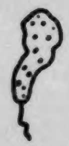
NONE of these is a PLAP:

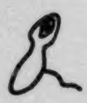


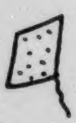
1.1.05 Y/29 Which ONE of these is a PLAP?

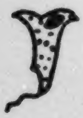
VS


A


B


C


D

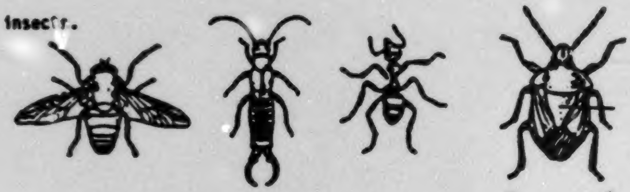

E

p-value

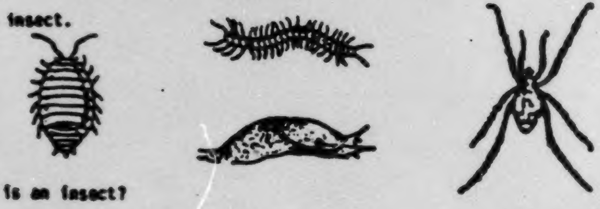
A. . . . . ☐ 2
B. . . . . ☐ 10
C. . . . . ☐ 9
D. . . . . ☐ 2
E. . . . . ☒ 65

F. I don't know . . . . ☐ 12

ALL of these are insects.

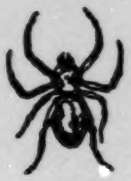


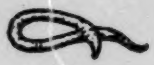
NONE of these is an insect.

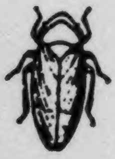


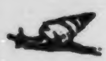
1.1.06 Y/34 Which ONE of these is an insect?

ST


A


B


C


D

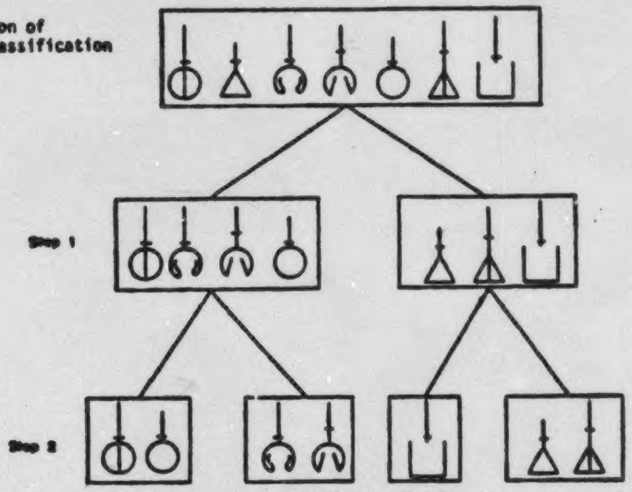
p-value

A. . . . . ☐ 12
B. . . . . ☐ 1
C. . . . . ☒ 83
D. . . . . ☐ 2

E. I don't know . . . . ☐ 2

OBJECTIVE 1.1: CLASSIFY

Here is a collection of 'Doodles' and a classification tree for them.



1.1.07 Z/10 What is the reason for dividing the groups in Step 1 into the four smaller groups of Step 2?

W

p-value

A. Long tails are divided from short tails. ☐ 5

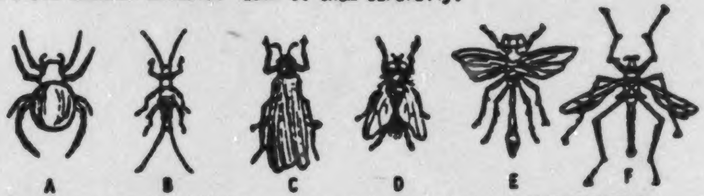
B. Open figures are divided from closed figures. . . . . ☒ 32

C. Curved boundaries are divided from straight boundaries. . . . . ☐ 30

D. Those cut into halves are divided from those not cut into halves. ☐ 8

E. I don't know. . . . . ☐ 27

Here are six unknown animals. Look at them carefully.



Use the identification key below to find out the name of CREATURE F.

Step 1.	wings no wings	Go to Step 2 Go to Step 5
Step 2.	wings stick out to side wings do not stick out to side	Go to Step 3 Go to Step 4
Step 3.	hind legs as long as body hind legs shorter than body	Cranefly Thread-waisted Wasp
Step 4.	wings cover all of abdomen (rear end) wings do not cover all of abdomen	Leaf Bug Housefly
Step 5.	six legs eight legs	Bristletail Spider

1.1.08 Z/15 Creature F is a

VS

p-value

A. Thread-waisted Wasp. . . . . ☐ 4

B. Cranefly. . . . . ☒ 72

C. Leaf Bug. . . . . ☐ 3

D. Bristletail . . . . ☐ 14

E. I don't know . . . . ☐ 6

OBJECTIVE 1.1: CLASSIFY

ALL of these are felines.

Lion
Cougar
Cat
Cheetah

NONE of these is a feline.

Wolf
Bear
Cow
Bat

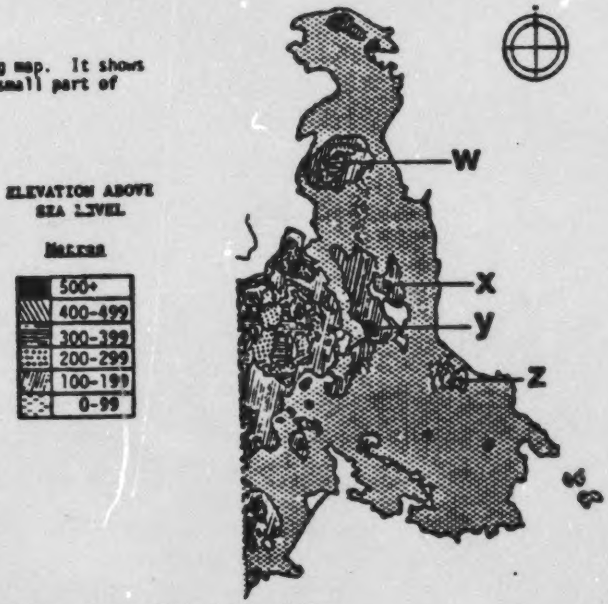
1.1.09 Z/20 Which ONE of the following is a feline? p-value

ST

A. Dog . . . . ☐ 4
B. Seal . . . . ☐ 3
C. Beaver . . . . ☐ 2
D. Tiger . . . . ☒ 87
E. I don't know . . . . ☐ 4

OBJECTIVE 1.2: COMMUNICATE

Look at the following map. It shows the elevations of a small part of British Columbia.


ELEVATION ABOVE SEA LEVEL
Metres
500+
400-499
300-399
200-299
100-199
0-99
W
X
Y
Z

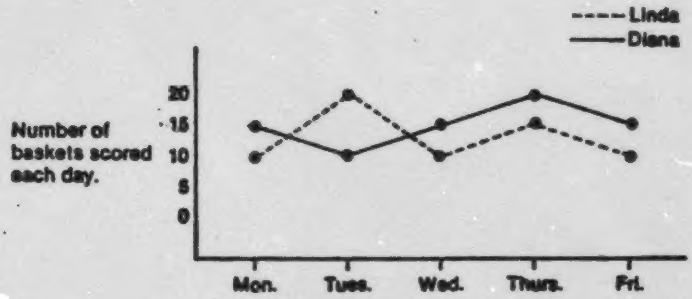
1.2.01 X/14 Which one of the following observations is correct? p-value

M

A. The land is lower in the west than in the east. . . . . ☐ 11
B. The land is hilly in the west and quite flat in the east. . . . . ☒ 48
C. W, X, Y and Z probably represent lakes. . . . . ☐ 15
D. Much land in the north and south is below sea level. . . . . ☐ 10
E. I don't know. . . . . ☐ 16

OBJECTIVE 1.2: COMMUNICATE

In basketball practice, Linda and Diana shot 20 shots every day for five days. The graph shows the number of baskets scored each day.

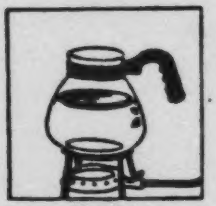


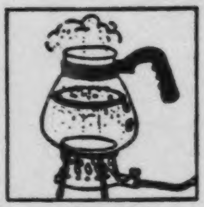
1.2.02 X/36 Look at the graph. Which of the following statements is correct? p-value

VS

A. Diana scored more baskets than Linda on Monday and Friday. . . . . ☒ 72
B. Linda scored fewer baskets than Diana on two days only. . . . . ☐ 8
C. Diana and Linda scored the same number of baskets on Tuesday. . . . . ☐ 6
D. Linda scored more baskets than Diana on Friday. . . . . ☐ 5
E. I don't know . . . . ☐ 8

Here are two pictures of a pot of water on a stove. Picture 2 was taken 5 minutes after picture 1.


Picture 1


Picture 2

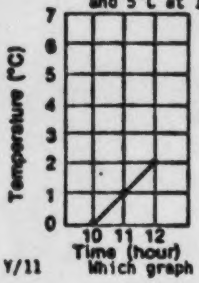
1.2.03 X/38 Which choice is the BEST way of telling that there has been a CHANGE? p-value

S

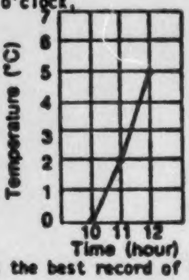
A. The water is boiling in picture 2. . . . . ☐ 13
B. The gas is on in picture 2. . . . . ☐ 6
C. The water gets hot when the gas is on. ☐ 13
D. The water is not boiling in picture 1. ☐ 2
E. The water is boiling in picture 2, but it is not boiling in picture 1. . . . . ☒ 64
F. I don't know . . . . ☐ 2

OBJECTIVE 1.2: COMMUNICATE

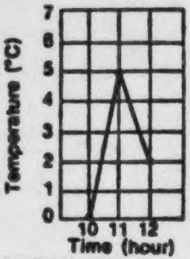
Some children found that the temperature was 0°C at 10 o'clock, 2°C at 11 o'clock, and 5°C at 12 o'clock.



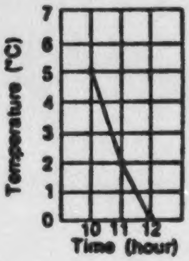
A



B



C



D

1.2.04 Y/11 Which graph is the best record of their findings?

VS

		p-value
A.	☐	5
B.	☒	77
C.	☐	9
D.	☐	5
E. I don't know.	☐	5

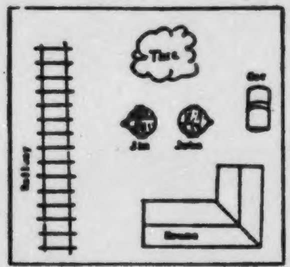
When large amounts of warm water are dumped into a river, the river itself is heated. The temperature of the water may be raised only a few degrees. Yet these few degrees can change the animal and plant life in the river. Heat causes a loss of oxygen in the water. Fish no longer do well and some kinds die. Without enough oxygen, bacteria in the river cannot break down waste matter. The river is no longer clean.

1.2.05 Y/15 What is the MAIN IDEA in this paragraph?

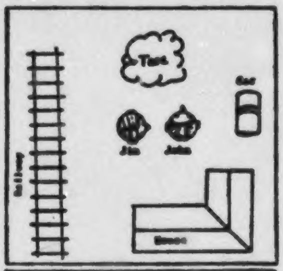
VS

		p-value
A. Heat causes water to lose oxygen.	☐	17
B. Fish and bacteria do not do well without oxygen	☐	6
C. Some fish cannot survive in warm water.	☐	6
D. Large amounts of warm water can be dangerous to life in rivers.	☒	67
E. I don't know	☐	4

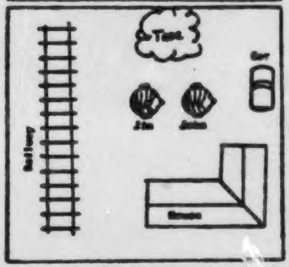
In the diagrams below you are looking down on a scene from an airplane. Jim says, "The car which is in front of me is behind John and the tree on my left is on his right".



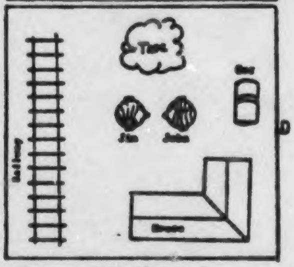
A



B



C



D

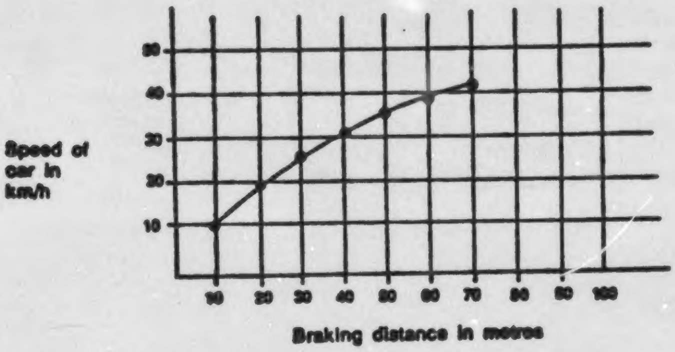
1.2.06 Y/40 According to Jim's description, which is the correct diagram?

ST

		p-value
A.	☐	10
B.	☐	4
C.	☐	6
D.	☒	76
E. I don't know	☐	5

OBJECTIVE 1.2: COMMUNICATE

The graph below shows how many metres it takes a car to stop after braking (braking distance), when the car is travelling at different speeds. Use this graph to answer questions 5 and 6.



1.2.07 Z/05 Look at the graph. Predict the braking distance at 15 km/h.

S

p-value

A. 10 metres . . . . ☐ 6
B. 15 metres . . . . ☒ 63
C. 5 metres . . . . ☐ 8
D. 20 metres . . . . ☐ 10

E. I don't know . . . . ☐ 13

1.2.08 Z/06 Look at the graph again. Predict the braking distance at 44 km/h.

M

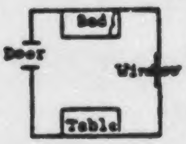
p-value

A. 70 metres . . . . ☐ 20
B. 75 metres . . . . ☒ 43
C. 100 metres . . . . ☐ 4
D. 60 metres . . . . ☐ 16

E. I don't know . . . . ☐ 18

1.2.09 Z/22 A girl enters a room. There is a bed along the wall to her LEFT, a window in the wall in FRONT of her and a table along the wall to her RIGHT. Which of the rooms below did she enter?

ST


Bed
Door
Window
Table

A

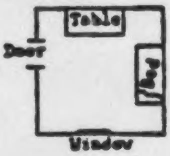


Table
Door
Bed
Window

B

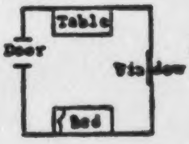
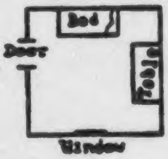


Table
Door
Window
Bed

C


Bed
Door
Table
Window

D

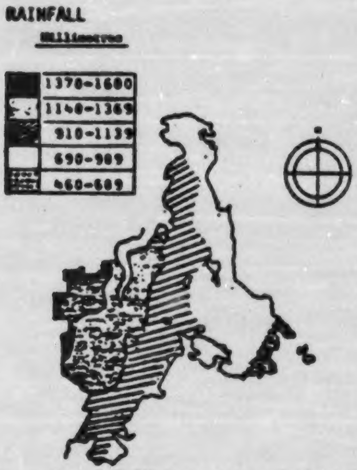
p-value

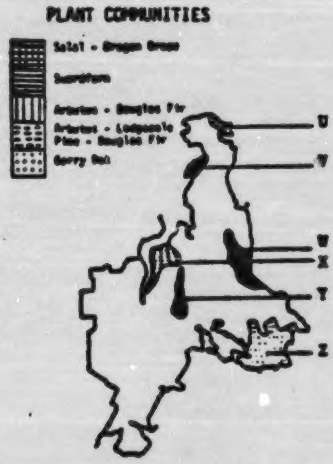
A. . . . . ☒ 87
B. . . . . ☐ 2
C. . . . . ☐ 5
D. . . . . ☐ 5

E. I don't know . . . . ☐ 1

OBJECTIVE 1.3: INTERPRET DATA

Here are two maps of the same area. One shows the rainfall and the other shows where some plant communities grow. Use these maps to answer questions 4 and 5.


RAINFALL
Millimetres
1370-1600
1140-1369
910-1139
690-909
460-689


PLANT COMMUNITIES
Salal - Oregon Grape
Swordfern
Arbutus - Douglas Fir
Arbutus - Lodgepole Pine - Douglas Fir
Garry Oak
U
V
W
X
Y
Z

1.3.01 X/04 How much rainfall in one year is best for growth of Garry Oak trees? *p-value*

VS

A. Less than 460 mm . . . . ☐ 5
B. 460 - 689 mm . . . . ☒ 61
C. 690 - 909 mm . . . . ☐ 18
D. 910 - 1139 mm . . . . ☐ 4

E. I don't know . . . . ☐ 13

1.3.02 X/05 According to the maps, which is the wettest place to go pick Swordfern leaves? *p-value*

M

A. W . . . . ☐ 33
B. X . . . . ☐ 11
C. Y . . . . ☒ 41
D. Z . . . . ☐ 4

E. I don't know . . . . ☐ 11

In summer, John noticed that the air in his tires became hotter when his car was driven over a long distance. *p-value*

1.3.03 X/26 The statement above is an example of

VS

A. a theory. . . . . ☐ 11
B. a principle . . . . ☐ 8
C. an observation. . . . . ☒ 71
D. a law. . . . . ☐ 6

E. I don't know. . . . . ☐ 5

The treeline is the highest altitude at which trees can grow. The following table relates treeline to distance from the equator.

Distance from Equator	Treeline
1000 km	4000 m
2500 km	3500 m
5000 km	3000 m
6500 km	1500 m

1.3.04 Y/08 According to the table above, the farther you are from the equator *p-value*

S

A. the higher the treeline. . . . . ☐ 12
B. the lower the treeline. . . . . ☒ 65
C. the taller the trees. . . . . ☐ 4
D. the smaller the trees. . . . . ☐ 11

E. I don't know. . . . . ☐ 8

OBJECTIVE 1.3: INTERPRET DATA

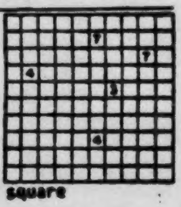
During the fall of the school year, an elementary school boy observed that, whenever he and his friends began to play ball on a street in their neighbourhood, there was an increase in car traffic. He noticed that the car traffic increase began at 4:00 p.m. The boy remembered that this did not happen during the summer months. The boy also knew that the secondary school on the same street closed at 3:45 p.m.

1.3.05 Y/22 Which is the BEST explanation for these observations?

ST

		p-value
A. People like to shop after 4:00 p.m.	☐	5
B. People who own cars do not want boys to play ball.	☐	3
C. The best time to drive is at 4:00 p.m.	☐	5
D. The traffic was caused by the teachers and students from the secondary school.	☒	81
E. I don't know.	☐	6

A student wished to find out how many ants there were in one square metre of his lawn. He divided one square metre up into 100 equal patches and counted the ants in five of the patches. He obtained the numbers of 3, 4, 4, 7 and 7.



1.3.06 Y/24 What is the BEST estimate for the total number of ants on one square metre?

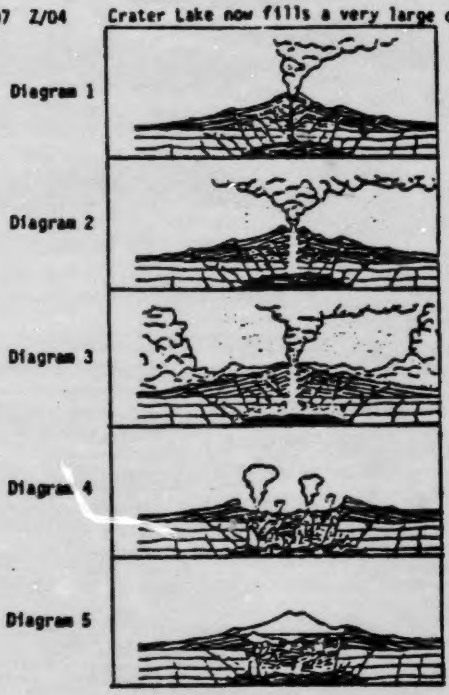
W

		p-value
A. 400	☐	6
B. 500	☒	26
C. 700	☐	6
D. None of the above	☐	45
E. I don't know	☐	17

This set of diagrams shows how Crater Lake was formed. Mt. Mazama erupted about 5000 B.C. in much the same way as Mt. St. Helens did in 1980.

1.3.07 Z/04 Crater Lake now fills a very large crater. How was the crater formed?

S



		p-value
A. Most of the peak of the volcano was blown away in the eruption.	☐	41
B. The crater was caused by a meteorite	☐	2
C. Most of the peak of the volcano collapsed into a space which was emptied below it.	☒	31
D. Most of the peak of the volcano was melted and ran down the sides	☐	13
E. I don't know.	☐	13

OBJECTIVE 1.3: INTERPRET DATA

David was asked to find out how much table salt would dissolve in 1,000 mL of water when the water temperature is at 25°C at the start of the experiment. During the experiment, he made the following observations.

1. Water temperature at the start was 25°C.
2. The solution had no odour.
3. After dissolving 390 grams of salt, no more salt would dissolve.
4. The temperature outside the classroom was 18°C.

1.3.08 Z/19 Which of the above observations would be LEAST helpful?

S

		p-value
A. 2, 3	☐	6
B. 1, 2	☐	10
C. 2, 4	☒	65
D. 1, 3	☐	14
E. I don't know	☐	7

Use the following information to answer question 32.

> Sue wanted to find out what might affect the length of bean seedlings. She placed a bean wrapped in moist tissue paper in each of TEN identical test tubes. She put FIVE test tubes in a rack in a sunny window. She put FIVE test tubes in a rack in a dark refrigerator. She measured the length of bean seedlings in each group after one week.

1.3.09 Z/32 What is the MOST important reason Sue used five test tubes under each condition?

S

		p-value
A. She wished to test five different factors.	☐	16
B. Averages provide better data in growth experiments.	☒	65
C. She was afraid she might break some test tubes.	☐	4
D. She had no good reason for doing this.	☐	6
E. I don't know.	☐	9

OBJECTIVE 1.4: IDENTIFY AND CONTROL VARIABLES

Use the following information to answer questions 6 and 7.

> Pat wanted to find out if temperature has an effect on the growth of bread mold. He grew the mold in nine containers, each with the same amount and type of nutrients.
>
> Three containers were kept at 0°C.
> Three containers were kept at room temperature (about 21°C).
> Three containers were kept at 90°C.
>
> The containers were examined at the end of four days.

1.4.01 X/06 What is the factor which Pat will look for?

VS

		p-value
A. Changes in the amount of nutrients in each container	☐	6
B. The amount of growth of the bread mold	☒	77
C. Numbers of containers at each temperature	☐	3
D. Differences in the temperature of the containers	☐	10
E. I don't know	☐	5

1.4.02 X/07 Which of the following did Pat keep the SAME in his containers?

M

1. The amount and type of nutrients
2. The length of time the mold was allowed to grow
3. The temperature of the containers
4. The amount of growth of the bread mold

		p-value
A. 1 only	☐	23
B. 2 only	☐	10
C. 1 and 2	☒	45
D. 1, 2, 3 and 4	☐	12
E. I don't know	☐	10

OBJECTIVE 1.4: IDENTIFY AND CONTROL VARIABLES

1.4.03 X/16 When we say that a scientist has formed an HYPOTHESIS about an experiment we mean that he has

W

p-value

A. designed equipment needed for the experiment. . . . . ☐ 3

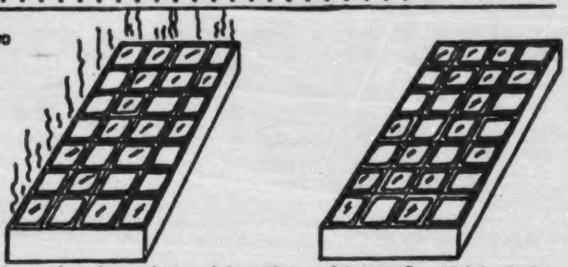
B. indicated which measurements will be made and how they should be carried out. ☐ 10

C. described how the experiment might turn out by stating how one factor might affect another. . . . . ☒ 41

D. observed all the things that happened during the experiment. . . . . ☐ 21

E. I don't know. . . . . ☐ 25

Below is a picture of two ice cube trays. One is filled with very hot water and one with cold water. Use this picture for questions 4, 5 and 6.



1.4.04 Y/04 Many people say, "Hot water makes ice cubes quicker than cold water". Which choice would be the best statement for helping you plan an experiment to test this?

W

p-value

A. The hotter the water you start with, the faster it will freeze into ice cubes . . . . ☒ 29

B. Hot water freezes into ice cubes fast . . . . ☐ 12

C. Hot water freezes at higher temperatures than cold water. . . . . ☐ 23

D. Hot water freezes into ice cubes faster because it turns on the refrigerator. . . ☐ 6

E. Hot water makes a steam which keeps the refrigerator going. . . . . ☐ 6

F. I don't know. . . . . ☐ 24

1.4.05 Y/05 If you wanted to test the statement you chose in question 4, which factor listed below is the only one you should allow to change during the experiment?

S

p-value

A. The temperature of the water you use . . . . ☒ 56

B. The amount of water in each tray . . . . ☐ 12

C. The position of the trays in the freezer . . . . ☐ 9

D. The refrigerator in which you put the trays . . . . ☐ 6

E. The kind of trays you use , ... ☐ 5

F. I don't know . . . . ☐ 11

1.4.06 Y/06 Some things that can change during your experiment in the previous question are listed below. Which one changes because of all the others?

S

p-value

A. The kind of trays you use . . . . ☐ 2

B. The refrigerator in which you put the trays . . . . ☐ 5

C. The time it takes for freezing . . . . ☒ 35

D. The temperature of the water you use . . . . ☐ 29

E. The amount of water in each tray . . . . ☐ 16

F. I don't know . . . . ☐ 13

1.4.07 Z/21 Molly suspected that 'vegetables contain water'. In order to test this idea she decided to test five different vegetables. She put each vegetable into a different test tube and heated them. She saw drops of liquid collect on the wall of each test tube. She tested the drops and found they were water. Molly's teacher suggested that this experiment needed a control. What control should Molly have used?

M

p-value

A. Heat a test tube with water in it . . . . ☐ 26

B. Heat a test tube with meat in it . . . . ☐ 3

C. Heat an empty test tube . . . . ☒ 41

D. Heat a test tube with cereal in it . . . . ☐ 4

E. I don't know . . . . ☐ 25

OBJECTIVE 1.4: IDENTIFY AND CONTROL VARIABLES

Use the following information to answer questions 30 and 31.

> Sue wanted to find out what might affect the length of bean seedlings. She placed a bean wrapped in moist tissue paper in each of TEN identical test tubes. She put FIVE test tubes in a rack in a sunny window. She put FIVE test tubes in a rack in a dark refrigerator. She measured the length of bean seedlings in each group after one week.

1.4.08 Z/30 Which of the following OTHER factors did Sue test for their effect on the length of the bean seedlings?

M

		p-value
A. Moisture and length of test tube	☐	9
B. Light and temperature	☒	40
C. Light and amount of time	☐	15
D. Temperature and moisture	☐	23
E. I don't know	☐	13

1.4.09 Z/31 Sue found that the seedlings grew better in the rack on the sunny window. Why might Michael criticize her experiment?

M

		p-value
A. There is no reason to criticize her experiment.	☐	27
B. She should have put different amounts of water in the test tubes.	☐	10
C. She cannot tell if the better growth is a result of temperature or of light or both.	☒	43
D. She did not need to use so many test tubes.	☐	8
E. I don't know.	☐	12

DOMAIN 2: KNOWLEDGE: RECALL AND UNDERSTAND

OBJECTIVE 2.1: BIOLOGICAL, PHYSICAL AND EARTH/SPACE SCIENCE CONCEPTS

2.1.01 X/01 For quick energy before a long race, it would be best for a runner to have

S

		p-value
A. a hard-boiled egg.	☐	9
B. a hot dog.	☐	1
C. a glass of milk.	☐	27
D. a candy bar.	☒	56
E. I don't know.	☐	6

2.1.02 X/10 A litre of water at a temperature of 50°C is mixed with a litre of water at 70°C. The temperature of the water just after mixing will be ABOUT

M

		p-value
A. 20°C.	☐	8
B. 50°C.	☐	2
C. 60°C.	☒	42
D. 70°C.	☐	6
E. 120°C.	☐	33
F. I don't know.	☐	9

2.1.03 X/11 The water that flows into the ocean as rivers

W

		p-value
A. all comes from town and city sewage disposal plants.	☐	5
B. all comes from lakes at the heads of the rivers.	☐	49
C. reaches the river by many paths through the air, over the land surface, or underground.	☒	35
D. was lifted from underground caverns to the surface of the earth by gravity.	☐	3
E. I don't know.	☐	11

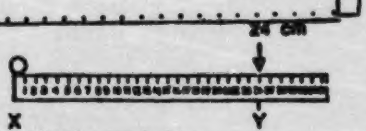
OBJECTIVE 2.1: BIOLOGICAL, PHYSICAL AND EARTH/SPACE SCIENCE CONCEPTS

2.1.04 X/15 If you counted the number of trees in a particular area, the maple trees would be called

p-value

A. a community. . . . . ☐ 15
B. a population. . . . . ☒ 22
C. a habitat. . . . . ☐ 21
D. an ecosystem. . . . . ☐ 24
E. I don't know. . . . . ☐ 18

The picture below shows a marble on a ruler.



2.1.05 X/17 If the marble rolls from X to Y in 2 seconds at a steady speed, how fast is it going?

VS

p-value

A. 12 cm per 2 seconds . . . . ☐ 12
B. 24 cm per second . . . . ☐ 8
C. 24 mm per second . . . . ☐ 4
D. 240 mL per second . . . . ☐ 2
E. 12 cm per second . . . . ☒ 70
F. I don't know . . . . ☐ 4

2.1.06 X/19 Which one of these is true about the planet Venus?

S

p-value

A. It is about the same size as the earth and is like it in most other ways. . . . . ☐ 4
B. Scientists know more about the surface of Venus than they do about Mars. . . . . ☐ 10
C. It is about the same size as the earth but has a very different atmosphere. . . . . ☒ 54
D. Venus has many satellites. . . . . ☐ 10
E. I don't know. . . . . ☐ 22

2.1.07 X/21 Which statement best describes how the earth's surface changes over billions of years?

S

p-value

A. A flat surface is gradually pushed up into steeper and steeper mountains until the world is covered with mountains. . . . . ☐ 12
B. Very steep mountains gradually wear down until most of the world is worn down to sea level. . . . . . ☐ 13
C. Very steep mountains and flat plains stay side by side for billions of years with little change. . . . ☐ 17
D. Very steep mountains gradually wear down into flat surfaces that may be again pushed up into mountains, and so on over and over again. . . . . . ☒ 40
E. I don't know. . . . . ☐ 17

2.1.08 X/31 Green plants are important to animals because the plants

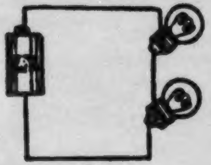
M

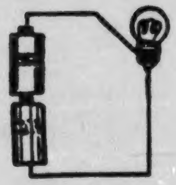
p-value

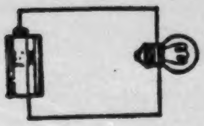
A. consume both food and oxygen. . . . . ☐ 16
B. consume food and give off oxygen. . . . . ☐ 16
C. consume food and give off carbon dioxide. . . . . ☐ 6
D. produce food and give off oxygen. . . . . ☒ 44
E. produce food and give off carbon dioxide. . . . . ☐ 11
F. I don't know. . . . . ☐ 6

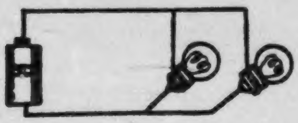
OBJECTIVE 2.1: BIOLOGICAL, PHYSICAL AND EARTH/SPACE SCIENCE CONCEPTS

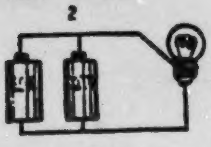
Below are five diagrams of electric circuits. Use these diagrams to answer questions 34 and 35.


1


2


3


4


5

2.1.09 X/34 Which diagram shows two cells in series?

S

		p-value
A. 1.	☐	10
B. 2.	☒	59
C. 3.	☐	3
D. 5.	☐	16
E. I don't know	☐	12

2.1.10 X/35 In which circuit will the light bulb(s) not work?

M

		p-value
A. 1.	☐	15
B. 2.	☐	4
C. 3.	☒	42
D. 4.	☐	26
E. I don't know	☐	12

2.1.11 X/37 Seeds come from which of the following parts of a plant?

VS

		p-value
A. Bark	☐	
B. Flower	☒	72
C. Leaf	☐	7
D. Root	☐	9
E. Stem	☐	7
F. I don't know	☐	4

2.1.12 Y/01 To which body system do the lungs belong?

VS

		p-value
A. Sensory	☐	1
B. Respiratory	☒	78
C. Circulatory	☐	8
D. Digestive	☐	4
E. I don't know	☐	9

2.1.13 Y/02 Which of the following helps to account for the fact that a compass can be used to find north on Earth?

S

		p-value
A. Earth has only one moon.	☐	6
B. Earth has a magnetic field.	☒	68
C. Earth reflects the Sun's light.	☐	6
D. Earth's temperature is not constant.	☐	3
E. I don't know.	☐	17

OBJECTIVE 2.1: BIOLOGICAL, PHYSICAL AND EARTH/SPACE SCIENCE CONCEPTS

2.1.14 Y/13 Which ONE of the following statements is true about seeds?

S

		p-value
A. All plants produce seeds.	☐	26
B. All seeds are good to eat.	☐	1
C. All fruits contain a large number of seeds.	☐	5
D. Every seed contains a young plant, stored food and a seed coat.	☒	63
E. I don't know.	☐	5

2.1.15 Y/18 A red ball weighs more than a blue ball. This means that

W

		p-value
A. in direct sunlight the red ball is shinier than the blue ball.	☐	3
B. the earth's pull on the red ball is greater than on the blue ball.	☒	38
C. the red ball is larger than the blue ball.	☐	39
D. the red ball can be made to move faster than the blue ball.	☐	7
E. I don't know.	☐	12

2.1.16 Y/23 It is possible to pass white light through a piece of glass called a prism and produce a spectrum (a short piece of a rainbow). What does the prism do to the light to make a spectrum?

S

		p-value
A. It subtracts colours from the light passing through.	☐	5
B. It adds colours to the light passing through.	☐	[illegible]
C. It breaks the light up into the colours from which it is made.	☒	54
D. It absorbs the light from the source.	☐	9
E. I don't know.	☐	15

2.1.17 Y/25 Which one of the following is a fossil fuel?

W

		p-value
A. Wood	☐	10
B. Paper	☐	1
C. Natural gas	☒	43
D. Limestone	☐	34
E. I don't know	☐	12

2.1.18 Y/26 Each year the Earth moves once around

VS

		p-value
A. Mars.	☐	1
B. Saturn.	☐	1
C. the Sun.	☒	78
D. the Moon.	☐	10
E. all of the other planets.	☐	4
F. I don't know.	☐	5

2.1.19 Y/28 An average serving of which of the following foods would provide the most protein for building and repairing body tissues?

W

		p-value
A. Boiled potatoes	☐	7
B. Green beans	☐	19
C. Lean meat	☒	38
D. Oatmeal	☐	13
E. White bread	☐	4
F. I don't know	☐	18

OBJECTIVE 2.1: BIOLOGICAL, PHYSICAL AND EARTH/SPACE SCIENCE CONCEPTS

2.1.20 Y/30 Which one of the following is a characteristic of ALL birds but of no other animal? Birds

M

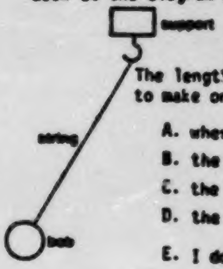
		p-value
A. tend to migrate.	☐	10
B. lay eggs.	☐	10
C. fly.	☐	24
D. have a body covered by feathers.	☒	52
E. I don't know.	☐	5

2.1.21 Y/33 Which one of the following is presently helping to shape the surface of the moon?

S

		p-value
A. Glaciers	☐	10
B. Plants	☐	4
C. Meteorites	☒	65
D. Streams	☐	4
E. I don't know	☐	17

Look at the diagram below.



-2.1.22 Y/39 The length of time required for a pendulum bob, like that shown above, to make one complete swing depends mostly upon

S

		p-value
A. where the bob is released.	☐	20
B. the mass of the bob.	☐	22
C. the temperature of the air.	☐	4
D. the length of the pendulum string.	☒	43
E. I don't know.	☐	10

2.1.23 Z/03 Night and day result from the

W

		p-value
A. earth revolving about the sun.	☐	36
B. spinning of the earth.	☒	45
C. moon going around the earth.	☐	4
D. sun revolving around the earth.	☐	11
E. I don't know	☐	3

2.1.24 Z/11 How is dew formed?

S

		p-value
A. Water vapour condenses on cold grass or other cold surfaces.	☒	62
B. It is left on the grass by rain.	☐	2
C. It forms in the air and falls on the grass.	☐	18
D. It forms from melted frost.	☐	12
E. I don't know.	☐	5

2.1.25 Z/14 How are sedimentary rocks formed?

W

		p-value
A. Melted rock cools.	☐	15
B. Already formed rock is changed by heat and pressure.	☐	19
C. Particles formed by erosion are cemented together.	☒	34
D. Erupted from volcanoes.	☐	12
E. I don't know	☐	20

OBJECTIVE 2.1: BIOLOGICAL, PHYSICAL AND EARTH/SPACE SCIENCE CONCEPTS

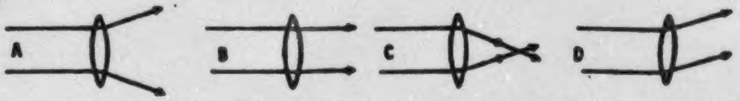
2.1.26 Z/16 Fertilization takes place when a sperm

VS

		p-value
A. reaches a certain age.	☐	5
B. enters an egg.	☒	74
C. becomes an egg.	☐	5
D. becomes an embryo.	☐	10
E. I don't know.	☐	6

2.1.27 Z/18 Which diagram below BEST shows what happens when light hits a camera lens?

M



		p-value
A.	☐	26
B.	☐	12
C.	☒	49
D.	☐	5
E. I don't know	☐	7

2.1.28 Z/23 Which ONE of the following produces seeds?

S

		p-value
A. Mushrooms	☐	1
B. Ferns	☐	4
C. Apples	☒	63
D. All plants produce seeds.	☐	31
E. I don't know	☐	2

2.1.29 Z/26 Which gas produced during photosynthesis is useful to animals?

M

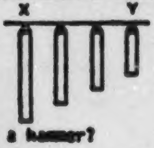
		p-value
A. Carbon dioxide	☐	14
B. Oxygen	☒	56
C. Carbon monoxide	☐	4
D. Nitrogen	☐	4
E. I don't know	☐	21

2.1.30 Z/33 Sugar is added to water at a temperature of 85°C until no more will dissolve. The sugar and water solution is allowed to cool. Which of the following is most likely to occur next?

M

		p-value
A. More sugar will dissolve in the water when the water reaches room temperature	☐	10
B. The sugar will slowly rise to the surface of the liquid in the container	☐	8
C. Crystals of sugar will begin to appear around the sides of the container	☒	49
D. The solution will gradually become cloudy as the sugar reacts with the water	☐	20
E. I don't know	☐	14

Some boys made a set of chimes by cutting four pieces of pipe to different lengths from a long metal pipe and hanging them as shown in the picture below.



2.1.31 Z/35 Which of the pipes gave the lowest note when they struck it with a hammer?

VS

		p-value
A. Pipe X	☒	65
B. Pipe Y	☐	17
C. All gave the same note.	☐	2
D. You cannot tell without trying.	☐	8
E. It depends on where you hit it.	☐	5
F. I don't know.	☐	3

OBJECTIVE 2.1: BIOLOGICAL, PHYSICAL AND EARTH/SPACE SCIENCE CONCEPTS

2.1.32 Z/36 In terms of the theory of natural selection, why do giraffes have such long necks?

S

		p-value
A. Stretching to get food in high trees has made their necks longer.	☐	10
B. There is something inside of giraffes which keeps making longer necks.	☐	4
C. Giraffe food contained vitamins which caused the vertebrae to lengthen.	☐	8
D. Giraffe necks have gotten longer and longer as time has gone on, but nobody has any idea why this is.	☐	17
E. Giraffes born with the longest necks have been able to stay alive when food was scarce and have passed this trait on to their offspring.	☒	43
F. I don't know.	☐	18

2.1.33 Z/40 When Tom threw his rubber ball into the air it came back to the ground because

S

		p-value
A. the air pushed it back.	☐	7
B. rubber always bounces back.	☐	6
C. the earth pulled it back.	☒	58
D. the air is very light.	☐	10
E. the earth is a large magnet.	☐	14
F. I don't know.	☐	4

OBJECTIVE 2.2: APPLICATIONS OF SCIENCE AND THE NATURE OF SCIENCE

2.2.01 X/08 Which ONE of the following substances is added to drinking water to help prevent tooth decay?

M

		p-value
A. Fluoride	☒	65
B. Chlorine	☐	15
C. Calcium	☐	9
D. Iodide	☐	1
E. I don't know	☐	9

2.2.02 X/12 Which of the following is a THEORY rather than an OBSERVATION?

M

		p-value
A. The centre of the earth is liquid.	☒	52
B. The average temperature of the South Pole is lower than the average temperature at the Tropic of Capricorn.	☐	8
C. A ship can start from a point, sail around the earth, and return to the same point.	☐	19
D. The temperature at the bottom of a very deep well is higher than the temperature at the surface.	☐	7
E. I don't know.	☐	14

2.2.03 X/22 What is the chief reason glass and plastic wastes are particularly troublesome?

M

		p-value
A. They form ugly litter.	☐	11
B. They are easily changed into poisonous substances.	☐	16
C. They float on top of bodies of water.	☐	7
D. They resist being changed by natural processes.	☒	54
E. I don't know.	☐	13

OBJECTIVE 2.2: APPLICATIONS OF SCIENCE AND THE NATURE OF SCIENCE

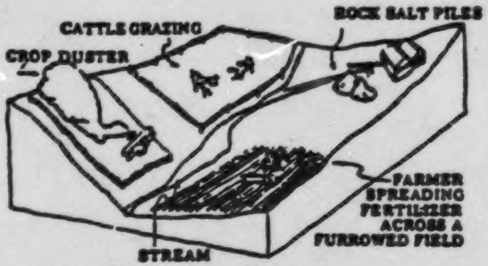
2.2.04 X/30 What does a scientific law describe? *p-value*

M

A. Directions for doing good experiments . . . . ☐ 13
B. Rules that scientists must obey . . . . ☐ 30
C. Relationships between events in nature . . . . ☒ 34
D. Good guesses about how things happen . . . . ☐ 7

E. I don't know . . . . ☐ 16

Examine the following diagram.



2.2.05 Y/16 What effect can the crop duster, cattle, salt stored in piles outdoors, and farmer spreading fertilizer ALL have? *p-value*

W

A. Improve the soil . . . . ☐ 24
B. Kill insects that attack crops . . . . ☐ 13
C. Make plants form bigger and faster . . . . ☐ 10
D. Make the stream water impure . . . . ☒ 42

E. I don't know . . . . ☐ 11

2.2.06 Y/31 Scientists of today can work on more complex problems than the scientists of the past because they *p-value*

S

A. are more intelligent than earlier scientists. . . . . ☐ 16
B. work much harder than earlier scientists. . . . . ☐ 4
C. have more imagination than earlier scientists. . . . . ☐ 7
D. build on the work of earlier scientists. . . . . ☒ 66

E. I don't know. . . . . ☐ 7

2.2.07 Y/35 Today, almost no one gets polio because *p-value*

S

A. bad water, which used to cause polio, has been cleaned up. . . . . ☐ 2
B. doctors have found new drugs which cure polio. . . . . ☐ 20
C. people eat better food and get more exercise to stay healthy. . . . . . . ☐ 7
D. people are given a vaccine which keeps them from getting polio. . . . . . ☒ 64

E. I don't know. . . . . ☐ 6

2.2.08 Y/36 Most things fall if they are not held up (law of gravity) but helium filled balloons rise. Scientists seek to explain this by *p-value*

M

A. rejecting the law of gravity because it does not seem to work for helium balloons. . . . . ☐ 6
B. forgetting it, because the world is unexplainable anyway. . . . . ☐ 4
C. assuming that helium balloons are an exception to the law of gravity. . . ☐ 25
D. looking for a second factor besides gravity acting on helium balloons. . . ☒ 41

E. I don't know. . . . . ☐ 24

OBJECTIVE 2.2: APPLICATIONS OF SCIENCE AND THE NATURE OF SCIENCE

2.2.09 Z/07 Which of the following areas of science has been completely investigated and is thoroughly understood?

M

p-value

A. Weather . . . . ☐ 13
B. Electricity . . . . ☐ 17
C. Gravity . . . . ☐ 16
D. None of the above . . . . ☒ 41
E. I don't know . . . . ☐ 11

2.2.10 Z/17 Thermal windows have two panes of glass with air trapped between them. They limit heat loss from a house by reducing

S

p-value

A. convection. . . . . ☐ 13
B. radiation. . . . . ☐ 7
C. heat conduction. ☒ 47
D. reflection. . . . . ☐ 7
E. I don't know. . . . . ☐ 25

2.2.11 Z/28 Which ONE of the following is prepared from the seeds of plants?

M

p-value

A. Tea . . . . ☐ 36
B. Flour . . . . ☒ 49
C. Salt . . . . ☐ 2
D. Sugar . . . . ☐ 5
E. I don't know . . . . ☐ 7

2.2.12 Z/39 You were doing an investigation into the boiling temperature of corn syrup and found that it boiled at 130°C. You read in your science text, however, that corn syrup boils at 125°C. When you report your results to the class in front of your teacher you should

M

p-value

A. assume your thermometer was wrong and report 125°C as your finding. ☐ 5
B. report your 130°C results regardless of what people might think. . . . . ☒ 44
C. report only the 125°C since that is what it should be. . . . . ☐ 10
D. report that you made an error and will redo the investigation. ☐ 30
E. I don't know. . . . . ☐ 12

OBJECTIVE 2.3: SAFETY PROCEDURES

2.3.01 X/03 During science class, you drop a glass jar and break it. There is glass all over the floor. What should you do?

S

p-value

A. Try to pick up the pieces yourself. . . . . ☐ 2
B. Throw the broken pieces into the wastepaper basket. . . . . ☐ 6
C. Do not touch the glass, but tell the teacher right away. . . . . ☒ 77
D. Brush up the glass with a paper towel. . . . . ☐ 15
E. I don't know. . . . . ☐ 1

OBJECTIVE 2.3: SAFETY PROCEDURES

2.3.02 X/18 What is the safe way to smell odours?

M

		p-value
A. Wear a gas mask and keep far from the source of the odours.	☐	8
B. Waft the gas toward your nose with your hand.	☒	58
C. Leave the area, because you should never deliberately smell chemicals.	☐	20
D. Bring the container giving odours close to your nose.	☐	6
E. I don't know.	☐	7

2.3.03 X/20 You need to move a piece of metal but think it might be very hot. How can you find out safely?

M

		p-value
A. Touch it with the tip of your finger.	☐	2
B. Bring the back of your hand up close to it.	☒	51
C. Splash water on it.	☐	37
D. Touch it with the bulb of a thermometer.	☐	7
E. I don't know.	☐	3

2.3.04 X/39 If acid is spilled on your skin, what should you do immediately?

M

		p-value
A. Pour alkali on the affected part.	☐	2
B. Wash the affected part with water.	☒	78
C. Cover the affected part with a dry sponge.	☐	4
D. Apply antiseptic cream to the affected part.	☐	6
E. I don't know.	☐	10

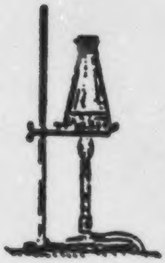
2.3.05 Y/07 What is the WORST thing you could do if your clothes catch fire?

M

		p-value
A. Wrap a coat or blanket around yourself.	☐	5
B. Roll on the floor.	☐	6
C. Run for help.	☒	83
D. Put water on your clothes.	☐	5
E. I don't know.	☐	1

2.3.06 Y/10 A student is boiling water in a stoppered glass jar or flask, as shown. What precaution would you take if you saw this?

W



		p-value
A. Immediately turn off the gas to the burner.	☒	35
B. Make sure the stopper is in tightly so the steam cannot escape.	☐	5
C. Find out why he/she is doing the investigations.	☐	23
D. Keep the burner turned down to low heat.	☐	29
E. I don't know.	☐	8

2.3.07 Y/14 After studying jars of pond water at your desk, it is important to

S

		p-value
A. wash your hands with water.	☐	16
B. wash your hands and desk top with soap and water.	☒	72
C. spray the room with vinegar and water.	☐	1
D. stand under a hot light.	☐	1
E. I don't know.	☐	9

OBJECTIVE 2.3: SAFETY PROCEDURES

2.3.08 Y/20 If acid is splashed into someone's eye, what should be done immediately?

S

p-value

A. Apply a bandage with antiseptic cream to the area. . . . . ☐ 2
B. Keep the eyelid closed and call for a doctor. . . . . ☐ 6
C. Spray or pour water on the eye. . . . . ☒ 84
D. Put baking soda on the area around the eye. . . . . ☐ 2
E. I don't know. . . . . ☐ 5

2.3.09 Z/01 Your teacher asks you to find out all you can about some liquid which looks like soda pop. What should you NOT do?

S

p-value

A. Get your friend to taste it . . . . ☒ 79
B. Pour a little into a beaker containing an old tooth . . . . ☐ 6
C. Test it for sugar . . . . ☐ 4
D. Test it for odours . . . . ☐ 6
E. I don't know . . . . ☐ 5

2.3.10 Z/13 Why should sodium hydroxide (lye or drano) be treated very carefully?

M

p-value

A. It sets fire to wood. . . . . ☐ 1
B. It forms a poisonous vapour. . . . . ☐ 21
C. It explodes in air. . . . . ☐ 3
D. It is very corrosive on skin and clothing. . . . . ☒ 57
E. I don't know. . . . . ☐ 18

2.3.11 Z/27 What is the MOST likely injury you could get from a classroom animal, such as a gerbil or guinea pig?

S

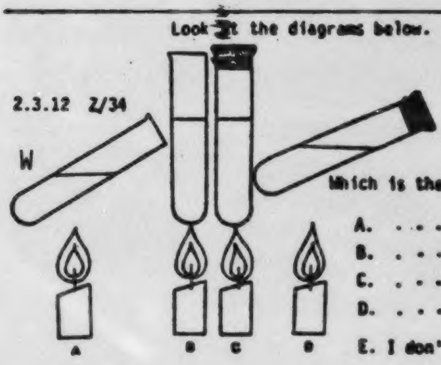
p-value

A. A sting . . . . ☐ 1
B. A disease . . . . ☐ 16
C. A kick . . . . ☐ 2
D. A bite . . . . ☒ 79
E. I don't know . . . . ☐ 2

Look at the diagrams below.

2.3.12 Z/34

W



Which is the correct method of heating a liquid in a test tube?

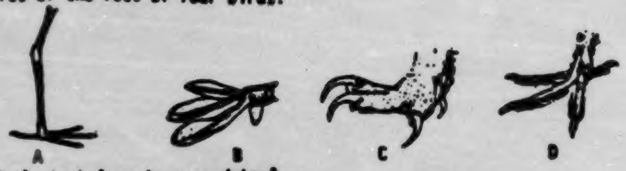
p-value

A. . . . . ☒ 34
B. . . . . ☐ 46
C. . . . . ☐ 11
D. . . . . ☐ 8
E. I don't know . . . . ☐ 2

DOMAIN 3: HIGHER LEVEL THINKING

OBJECTIVE 3.1: APPLY BIOLOGICAL, PHYSICAL AND EARTH/SPACE SCIENCE CONCEPTS

Below are pictures of the feet of four birds.



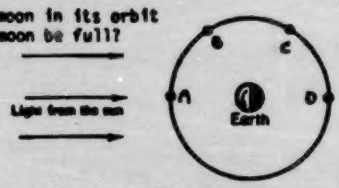
3.1.01 X/02 Which foot is likely to belong to a predator?

VS

		p-value
A.	☐	2
B.	☐	7
C.	☒	72
D.	☐	6
E. I don't know	☐	12

3.1.02 X/13 The letters A to D show some positions of the moon in its orbit around the earth. At what position would the moon be full?

W



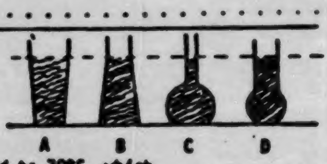
		p-value
A.	☐	29
B.	☐	7
C.	☐	15
D.	☒	34
E. I don't know	☐	14

3.1.03 X/25 Suppose that some clear night the moon exploded. Which ONE of the following would happen?

M

		p-value
A. We could see the explosion and hear a terrific noise at the same time.	☐	7
B. We could see the explosion, but would hear no sound.	☒	25
C. The sound would reach us before we saw the explosion.	☐	12
D. We could hear the sound after we saw the explosion.	☐	49
E. I don't know.	☐	7

A litre of water at room temperature (20°C) is poured into each of the four containers shown below.



3.1.04 X/33 When the water in all four containers is heated to 70°C, which container will have the highest water level?

S

		p-value
A.	☐	14
B.	☐	4
C.	☒	64
D.	☐	8
E. I don't know.	☐	10

3.1.05 X/40 A lizard is a reptile and a salamander is an amphibian. Which of the following is true?

M

		p-value
A. Lizards do not lay eggs.	☐	7
B. Lizard eggs hatch into tadpole-like creatures.	☐	10
C. Salamander eggs hatch into small salamanders.	☐	29
D. Salamander eggs hatch into tadpole-like creatures.	☒	30
E. I don't know.	☐	24

OBJECTIVE 3.1: APPLY BIOLOGICAL, PHYSICAL AND EARTH/SPACE SCIENCE CONCEPTS

3.1.06 Y/03 Imagine that all the wolves and cougars in a B.C. forest community have died. Which one of the following is likely to happen?

VS

		p-value
A. The number of deer will go down in the first few years because there are no animals which need them for food.	☐	4
B. There will be hardly any change in the number of deer.	☐	6
C. In a few years there will be too many deer and they will harm the plant growth.	☒	70
D. Some other wild animals in the community will begin to feed on deer.	☐	15
E. I don't know.	☐	5

A poem entitled "The Ancient Mariner" contains the lines:

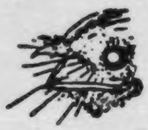
"The sun now rose upon the right
Out of the sea came he,
Still hid in mist, and on the left
Went down into the sea."

3.1.07 Y/09 In which direction was the Ancient Mariner sailing?

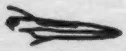
M

		p-value
A. North	☒	29
B. South	☐	16
C. East	☐	19
D. West	☐	24
E. I don't know	☐	12

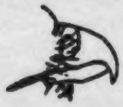
Here are pictures of some bills of birds.



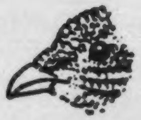
A



B



C



D

3.1.08 Y/12 Which bill is likely to belong to a bird which PICKS UP SEEDS AND INSECTS from the ground?

S

		p-value
A.	☐	20
B.	☐	28
C.	☐	3
D.	☒	46
E. I don't know	☐	2

When a movie screen is 3 m from a projector, the picture on the screen is 70 cm tall. The screen is then moved until it is 6 m from the projector.

3.1.09 Y/32 How tall will the picture now be?

S

		p-value
A. 35 cm	☐	17
B. 70 cm	☐	4
C. 140 cm	☒	61
D. 420 cm	☐	8
E. I don't know	☐	9

OBJECTIVE 3.1: APPLY BIOLOGICAL, PHYSICAL AND EARTH/SPACE SCIENCE CONCEPTS

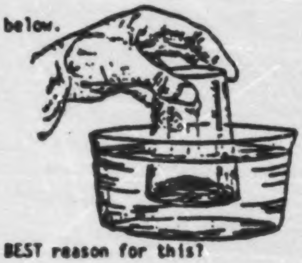
3.1.10 Y/37 Which of the following is described by this sequence of energy changes?

S

Chemical energy ⟶ Heat energy ⟶ Mechanical energy (with wasted heat)

		p-value
A. A flashlight is turned on.	☐	9
B. A candle is burned.	☐	10
C. Gasoline is burned to power a car.	☒	47
D. Electric current is used to run a refrigerator.	☐	16
E. I don't know.	☐	17

A glass is pushed down in a bowl of water as shown below.



3.1.11 Z/02 The water does not rise in the glass. What is the BEST reason for this?

VS

		p-value
A. Air dissolves in water.	☐	3
B. Air takes up space.	☒	70
C. Water pushes in all directions.	☐	6
D. Water is heavier than air.	☐	14
E. I don't know.	☐	7

A typical Arctic food chain is

microscopic plants ⟶ tiny animals (animal plankton) ⟶ krill (shrimp-like creatures) ⟶ seals ⟶ polar bears

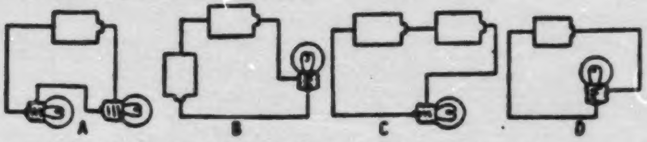
3.1.12 Z/09 If thousands of polar bears were killed, what would likely happen to the krill population?

M

		p-value
A. Go down at first	☒	37
B. Go up at first and level off	☐	21
C. Stay the same	☐	15
D. Go up and then go down	☐	14
E. I don't know	☐	13

OBJECTIVE 3.1: APPLY BIOLOGICAL, PHYSICAL AND EARTH/SPACE SCIENCE CONCEPTS

Identical cells and bulbs are used to make the following circuits. Use these diagrams to answer questions 24 and 25.



3.1.13 Z/24 In which diagram will the light from the bulb or bulbs be brightest? *p-value*

S

A. . . . . ☐ 19
B. . . . . ☐ 16
C. . . . . ☒ 49
D. . . . . ☐ 7
E. I don't know . . . . ☐ 8

3.1.14 Z/25 Which bulb or bulbs will not light up at all? *p-value*

M

A. . . . . ☐ 24
B. . . . . ☒ 32
C. . . . . ☐ 6
D. . . . . ☐ 23
E. I don't know . . . . ☐ 12

3.1.15 Z/29 Many birds have an organ called a GIZZARD. This organ is used to grind up seeds into a paste. Of which body system is a gizzard a part? *p-value*

VS

A. Circulatory . . . . ☐ 3
B. Respiratory . . . . ☐ 4
C. Digestive . . . . ☒ 77
D. Reproductive . . . . ☐ 5
E. I don't know . . . . ☐ 11

OBJECTIVE 3.2: USE RATIONAL AND CRITICAL THINKING

A pupil tried a magnet on several things and made the following table.

NAME OF SUBSTANCE	WILL ATTRACT	WILL NOT ATTRACT
IRON NAIL	X	
COPPER WIRE		X
SILVER COIN		X
NICKEL COIN	X	
STEEL SINK	X	
WOOD DOOR		X
NEWSPAPER		X
BRASS DOOR KNOB		X

3.2.01 X/20 What is the MOST logical conclusion the pupil can make about the data in the table? *p-value*

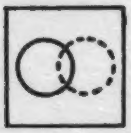
W

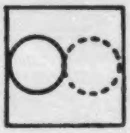
A. Magnets only attract metals with iron in them. . . . . ☐ 21
B. Magnets attract some metals. . . . . ☒ 34
C. There is no pattern as to which magnets will and will not attract. . . . . ☐ 9
D. Magnets attract metals and do not attract non-metals. . . . . ☐ 30
E. I don't know. . . . . ☐ 5

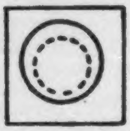
OBJECTIVE 3.2: USE RATIONAL AND CRITICAL THINKING

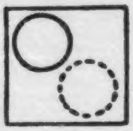
3.2.02 X/23 In a school gym the boys and girls put down two rope circles. In one circle they put all the boys. In the other circle they put all the blue-eyed students. How must the circles be arranged?

S


A


B


C


D

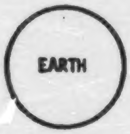
p-value

A. . . . . ☒ 48
B. . . . . ☐ 6
C. . . . . ☐ 16
D. . . . . ☐ 24
E. I don't know . . . . ☐ 6

Suppose you wish to make a scale model of the solar system. You know the following.

The diameter of Earth is 12,800 km
The diameter of Mercury is 4,800 km

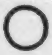
You make a model of the earth of the size shown below:

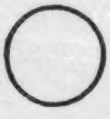


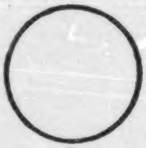
3.2.03 X/27 Which of the following is approximately the right size for the model of Mercury?

S

A


B


C


D

p-value

A. . . . . ☐ 18
B. . . . . ☒ 59
C. . . . . ☐ 13
D. . . . . ☐ 5
E. I don't know . . . . ☐ 5

3.2.04 X/32 In order to determine the cause of disease X, one thousand people with the disease were examined. All had Bacteria Q in their mouths. The conclusion reached was that Bacteria Q is the cause of the disease. Which of the following can BEST be said about the above?

S

p-value

A. The conclusion is false because the data do not support it. . . . . ☐ 4
B. The conclusion does not deal with the problem. . . . . ☐ 5
C. The conclusion is a good one because the data support it. . . . . ☐ 21
D. No conclusion should be made until people without the disease are examined. . . . . ☒ 51
E. I don't know. . . . . ☐ 19

3.2.05 Y/17 You know that all insects have six legs. You find a small animal with six legs. What can you say about it?

W

p-value

A. It is definitely NOT an insect. ☐ 6
B. It is definitely an insect. . . . . ☐ 41
C. It could be an insect. . . . . ☒ 37
D. It may be a spider. . . . . ☐ 15
E. I don't know. . . . . ☐ 1

3.2.06 Y/19 Which ONE of the following facts would you NOT use if you wished to convince someone that "Acid rains may ruin our lakes."

M

p-value

A. Some chemicals form acid in the atmosphere. . . . . ☐ 12
B. Too much acid in lakes will kill creatures living there. . . . . ☐ 24
C. Many industries pour chemicals into the atmosphere. . . . . ☐ 17
D. Acid in water will damage metals. . . . . ☒ 34
E. I don't know. . . . . ☐ 13

OBJECTIVE 3.2: USE RATIONAL AND CRITICAL THINKING

3.2.07 Y/21

VS

Polio is a disease caused by small particles called viruses. Viruses are able to cause disease even after many years have passed. Polio has almost disappeared because of programs of vaccination (usually people are given drops of vaccine on a sugar cube). What should we do now?

p-value

A. Continue to vaccinate everyone against polio . . . . ☒ 70

B. Vaccinate only babies in an area where a case of polio appears . . . . ☐ 12

C. Stop vaccination programs because they are expensive . . . . ☐ 5

D. Vaccinate no one in the future because polio has almost disappeared . . . . ☐ 3

E. I don't know . . . . ☐ 12

3.2.08 Y/38

M

A soap company makes this statement: "Use only BRILLIANT soap — it will not harm the environment." What assumption does the soap company expect you to make?

p-value

A. Most soaps do not harm the environment. . . . . ☐ 10

B. BRILLIANT soap is more effective at cleaning than other soaps. . . . . ☐ 26

C. Choice of soap should depend on whether or not the soap will harm the environment. . . . . ☒ 49

D. Soaps other than BRILLIANT clean better. . . . . ☐ 5

E. I don't know. . . . . ☐ 10

3.2.09 Z/08

S

Your friend says that "Magnets attract metal". You give him some objects and a good magnet. He does a test and finds that the magnet attracts steel scissors and iron nails. How does this fact relate to his statement?

p-value

A. It supports the statement. . . . . ☒ 56

B. It contradicts the statement. . . . . ☐ 19

C. It gives no useful information about the statement. . . . . ☐ 16

D. I don't know . . . . ☐ 9

3.2.10 Z/12

VS

Ammonites were creatures that lived in the sea millions of years ago, but are not alive today. They had an outside shell, like a Chambered Nautilus does today. Some kinds of ammonites came in two sizes - very large or very small. Chambered Nautiluses also are large and small. The large ones are females and the small ones are males. Scientists conclude that small ammonites of one kind were males, while large ammonites of the same kind were females. Which of the following can be said about this conclusion?

p-value

A. Scientists have no interest in creatures which are extinct. . . . . ☐ 3

B. The conclusion is false because males are always bigger than females. . . . . ☐ 4

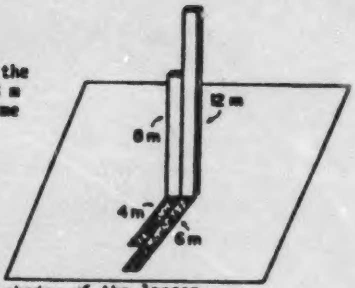
C. The conclusion is a poor one because we will never see a living ammonite. . . . . ☐ 16

D. The conclusion is a good one, although it can never be proved as definitely true. . . . . ☒ 64

E. I don't know. . . . . ☐ 13

OBJECTIVE 3.2: USE RATIONAL AND CRITICAL THINKING

Two poles are standing side by side as shown in the diagram below. One is 12 m tall, the other is 8 m tall. Their shadows are measured at the same time and are 6 m and 4 m long.



3.2.11 Z/37 Later in the day the shadows have changed. The shadow of the longer pole is now 9 m long. How long is the shadow of the shorter pole?

M

		p-value
A. 5 m	☐	12
B. 6 m	☒	26
C. 7 m	☐	48
D. 8 m	☐	6
E. I don't know	☐	8

3.2.12 Z/38 Our great grandparents used "mustard plasters" as a cure for chest colds. Which ONE of the following would be good scientific evidence for or against the effectiveness of this treatment?

W

		p-value
A. Data from controlled experiments on the use of mustard plasters on cold sufferers	☒	23
B. A prescription for mustard plasters in an old medical book	☐	8
C. Recommendations from several people who say mustard plasters cured them	☐	15
D. A chemical study of mustard to see what is in it	☐	29
E. I don't know	☐	24

APPENDIX G

Form 12X

school code

British Columbia
SCIENCE ASSESSMENT 1982

352

BACKGROUND INFORMATION

HOW TO MARK YOUR ANSWERS

Put an X beside your answer.

For example: Do you live in Canada?

Yes.......... X^{1}
No.......... ____^{2}

---

1. Did you write your school code number in the boxes on the front cover? If not, please do so now.

2. What is your date of birth?

Year:
1962 or earlier 6^{1}
1963.......... 32^{2}
1964.......... 59^{3}
1965.......... 3^{4}
1966.......... 0^{5}
1967 or later.. 0^{6}

Month:
January.......____^{01}
February......____^{02}
March.........____^{03}
April.........____^{04}
May...........____^{05}
June..........____^{06}
July..........____^{07}
August........____^{08}
September.....____^{09}
October.......____^{10}
November......____^{11}
December......____^{12}

3. Sex:
Male.......... 48^{1}
Female........ 49^{2}

4. What language did you use when you FIRST learned to speak?

English....... 84^{1}
Another language...... 15^{2}

5. What language do you NOW speak most often at home?

English....... 94^{1}
Another language...... 5^{2}

6. In Grade 8 were you attending a school

in this school district?.......... 81^{1}
elsewhere in British Columbia?.......... 9^{2}
in another province of Canada?......... 6^{3}
outside Canada?.... 3^{4}

7. Check ALL of the following which you have successfully completed. (*Mark all that apply*).

Science 8.......... 97^{1}
Science 9.......... 96^{1}
Science 10......... 94^{1}
Biology 11......... 40^{1}
Biology 12......... 8^{1}
Chemistry 11....... 31^{1}
Chemistry 12....... 5^{1}
Physics 11......... 21^{1}
Physics 12......... 2^{1}
Earth Science 11... 5^{1}
Geology 12......... 2^{1}
Other Science...... 8^{1}

8. Check ALL Science courses you are taking NOW? (*Mark all that apply*).

Not taking any now	48	1
Science 8	0	1
Science 9	0	1
Science 10	1	1
Biology 11	4	1
Biology 12	17	1
Chemistry 11	4	1
Chemistry 12	13	1
Physics 11	6	1
Physics 12	9	1
Earth Science 11	1	1
Geology 12	3	1
Other Science	6	1

9. In which grade are you currently enrolled?

Grade 9	0	1
Grade 10	0	2
Grade 11	1	3
Grade 12	98	4

10. Do you have a part-time job?

No (*Go to Question 12*)	39	1
Yes, involving work only on weekends	17	
Yes, involving work only on weekdays	5	3
Yes, involving work both weekdays and weekends	35	4

11. If you have a part-time job, how many hours per week do you spend on it?

Less than 5 hours	7	1
5-10 hours	29	2
10-20 hours	46	3
More than 20 hours	17	4

12. At this time, what do you plan to do immediately after leaving secondary school? (*Mark one only*).

Attend a business school	2	01	GO TO QUESTION 13
Attend vocational, art or trade training school	8	02	
Attend a technical institute	5	03	
Attend community college: university transfer program	14	04	
Attend community college: career program	10	05	
Attend a university	17	06	
Look for a job	12	07	GO TO PAGE 6
Take a year off and then return to an education program	13	08	
Take a year off and then look for a job	1	09	
Other plans	7	10	
Undecided	7	11	

13. Do you plan to attend a college, an institute or a university immediately after graduation? (*Mark one only*).

College *Go to Question 14*	46	1
Institute *Go to Question 15*	18	2
University *Go to Question 16*	31	3

14. Only Those Planning to Attend College

Which ONE of the following colleges is your first choice to attend?

Camosun College........	8	01
Capilano College.......	6	02
Cariboo College........	7	03
Douglas College........	8	04
East Kootenay College..	1	05
Fraser Valley College..	3	06
Kwantlen College.......	7	07
Malaspina College......	8	08
College of New Caledonia	7	09
North Island College...	1	10
Northern Lights College	0	11
Northwest College......	1	12
Okanagan College.......	10	13
Selkirk College........	4	14
Vancouver Community College...............	12	15
Out of Province........	4	16
Other..................	5	17
Undecided..............	6	18

NOW GO TO QUESTION 17

15. Only Those Planning to Attend An Institute

Which ONE of the following institutes is your first choice to attend?

B.C.I.T................	38	01
Emily Carr Institute of Fine Arts..............	2	02
Justice Institute of B.C.	0	03
Open Learning Institute	0	04
Pacific Marine Institute	1	05
Pacific Vocational Institute..............	29	06
Out of Province........	8	07
Other..................	10	08
Undecided..............	8	09

NOW GO TO QUESTION 17

16. Only Those Planning to Attend University

Which ONE of the following universities is your first choice to attend?

David Thompson University Centre..................	0	1
Simon Fraser University	17	2
University of B.C......	46	3
University of Victoria.	20	4
Out of Province........	8	5
Other..................	3	6
Undecided..............	4	7

17. All Planning to Attend a Post-Secondary Institution

Indicate the ONE general area in which you intend to study. (*Mark one only*).

Agriculture and Biological Sciences	4	01
Auto Mechanics	3	02
Business Management and Business Sciences	13	03
Communications	1	04
Community Services	2	05
Data Processing	4	06
Education	6	07
Electrical/Electronic Technologies	4	08
Engineering and Applied Sciences	5	09
Engineering Technologies	2	10
Fine, Applied and Performing Arts	4	11
General Arts	4	12
Health Professions and Occupations	8	13
Heavy Duty Mechanics	2	14
Hospitality Industry	1	15
Humanities	1	16
Mathematics and Physical Sciences	3	17
Primary Industries (e.g. Forestry, Mining)	1	18
Secretarial Science	2	19
Social Sciences	2	20
Other	15	21
I don't know	8	22

SCHOOL SCIENCE

Directions: The statements below tell how some students feel about SCHOOL SCIENCE. Read each statement and then CIRCLE the choice which best describes how you feel about it.

Here is an example about skating which shows how to mark your answer if you disagree with the statement.

SKATING IS A WASTE OF TIME.

Strongly Disagree 1	[✓ Disagree 2]	Can't Decide 3	Agree 4	Strongly Agree 5

Please be as honest as possible in rating each statement. There is no correct answer. Do not spend too much time on any one statement.

FORM 12X

1. I LIKE TO STUDY SCIENCE IN SCHOOL.

Strongly Disagree .07	Disagree .26	Can't Decide .16	Agree .45	Strongly Agree .06

2. I FEEL THE STUDY OF SCIENCE IN SCHOOL IS IMPORTANT.

Strongly Disagree .02	Disagree .10	Can't Decide .12	Agree .61	Strongly Agree .16

3. SCIENCE IS DULL.

Strongly Disagree .09	Disagree .52	Can't Decide .14	Agree .21	Strongly Agree .04

4. I DO NOT ENJOY SCIENCE.

Strongly Disagree .12	Disagree .47	Can't Decide .11	Agree .24	Strongly Agree .06

5. I WOULD LIKE TO STUDY MORE SCIENCE.

Strongly Disagree .11	Disagree .36	Can't Decide .23	Agree .26	Strongly Agree .04

6. SCIENCE CLASSES ARE BORING.

Strongly Disagree .05	Disagree .47	Can't Decide .18	Agree .25	Strongly Agree .06

7. SCIENCE IS A VALUABLE SUBJECT.

Strongly Disagree .01	Disagree .08	Can't Decide .13	Agree .59	Strongly Agree .1

8. TOO MANY HOURS IN SCHOOL ARE DEVOTED TO SCIENCE.

Strongly Disagree .05	Disagree .60	Can't Decide .25	Agree .08	Strongly Agree .01

(CONT'D) FORM 12X

9. SCIENCE SHOULD BE REQUIRED EVERY SCHOOL YEAR.

Strongly Disagree .16	Disagree .46	Can't Decide .13	Agree .21	Strongly Agree .04

10. WHAT ONE LEARNS IN SCIENCE IS USEFUL OUTSIDE OF SCHOOL.

Strongly Disagree .02	Disagree .12	Can't Decide .18	Agree .54	Strongly Agree .12

SCIENTISTS (12X)

1. SCIENTISTS ARE USUALLY ODD COMPARED WITH MOST OTHER PEOPLE I KNOW.

Strongly Disagree .06	Disagree .53	Can't Decide .20	Agree .18	Strongly Agree .03

2. SCIENTISTS USUALLY DON'T GO ALONG WITH THINGS ORDINARY PEOPLE LIKE TO DO.

Strongly Disagree .06	Disagree .53	Can't Decide .19	Agree .21	Strongly Agree .02

3. SCIENTISTS HAVE THE ANSWERS TO MOST OF THE PROBLEMS OF OUR SOCIETY.

Strongly Disagree .09	Disagree .51	Can't Decide .16	Agree .22	Strongly Agree .02

4. SCIENTISTS PUT A HIGH VALUE ON HUMAN LIFE.

Strongly Disagree .01	Disagree .11	Can't Decide .33	Agree .48	Strongly Agree .05

5. SCIENTISTS ARE PROBABLY RIGHT WHEN THEY SAY THAT THE PLANETS DO NOT DETERMINE SUCCESS AND FAILURE IN OUR DAILY LIVES.

Strongly Disagree .02	Disagree .10	Can't Decide .26	Agree .48	Strongly Agree .13

6. SCIENTISTS HAVE DONE MORE HARM THAN GOOD IN THIS WORLD.

Strongly Disagree .21	Disagree .51	Can't Decide .18	Agree .06	Strongly Agree .03

7. SCIENTISTS ARE HIGHLY INTELLIGENT.

Strongly Disagree .01	Disagree .10	Can't Decide .18	Agree .60	Strongly Agree .11

8. SCIENTISTS HAVE BEEN VERY HELPFUL TO MANKIND.

Strongly Disagree .01	Disagree .02	Can't Decide .13	Agree .66	Strongly Agree .17

(CONT'D) SCIENTISTS (12X)

9. MORE SCIENTISTS ARE URGENTLY NEEDED IN OUR SOCIETY.

Strongly Disagree .01 Disagree .16 Can't Decide .40 Agree .37 Strongly Agree .07

10. SCIENTISTS ARE NARROW MINDED PEOPLE.

Strongly Disagree .12 Disagree .51 Can't Decide .28 Agree .08 Strongly Agree .01

SCIENCE AND SOCIETY (12X)

1. SCIENTIFIC PROGRESS AND THE PROGRESS OF MAN GO TOGETHER.

Strongly Disagree .02 Disagree .11 Can't Decide .15 Agree .62 Strongly Agree .09

2. SCIENTIFIC RESEARCH SHOULD NOT GET ANY OF THE TAXPAYERS' MONEY.

Strongly Disagree .14 Disagree .54 Can't Decide .19 Agree .11 Strongly Agree .02

3. IN EVERYDAY LIFE SCIENCE IS NOT AS PRACTICAL AS COMMON SENSE.

Strongly Disagree .04 Disagree .25 Can't Decide .26 Agree .36 Strongly Agree .04

4. SCIENCE IS IMPORTANT IN OUR LIVES.

Strongly Disagree .01 Disagree .06 Can't Decide .11 Agree .69 Strongly Agree .13

5. SCIENCE IS NOT NECESSARY TO SOCIETY.

Strongly Disagree .19 Disagree .67 Can't Decide .09 Agree .05 Strongly Agree .01

6. SCIENTIFIC INVENTIONS AND DISCOVERIES HAVE DONE MORE GOOD THAN HARM FOR MANKIND.

Strongly Disagree .03 Disagree .12 Can't Decide .24 Agree .46 Strongly Agree .14

7. SCIENCE IS NOT IMPORTANT IN EVERYDAY LIFE.

Strongly Disagree .09 Disagree .59 Can't Decide .15 Agree .16 Strongly Agree .01

8. SCIENCE HAS CONTRIBUTED GREATLY TO THE ADVANCEMENT OF CIVILIZATION.

Strongly Disagree .01 Disagree .02 Can't Decide .09 Agree .64 Strongly Agree .24

9. THE PRODUCTS OF SCIENTIFIC WORK ARE MAINLY USEFUL TO SCIENTISTS BUT ARE NOT USEFUL TO THE AVERAGE PERSON.

Strongly Disagree .12 Disagree .52 Can't Decide .[illegible]4 Agree .21 Strongly Agree .01

(CONT'D) SCIENCE AND SOCIETY (12X)

10. SCIENCE WILL HAVE A TREMENDOUS EFFECT ON OUR LIVES IN THE FUTURE.

Strongly Disagree .01 Disagree .02 Can't Decide .07 Agree .56 Strongly Agree .34

11. SCIENCE EXISTS FOR THE BENEFIT OF MANKIND.

Strongly Disagree .01 Disagree .07 Can't Decide .22 Agree .59 Strongly Agree .11

12. I USE SCIENTIFIC IDEAS OR FACTS IN MY EVERYDAY LIFE.

Strongly Disagree .07 Disagree .30 Can't Decide .21 Agree .39 Strongly Agree .03

SPECIFIC ISSUES

Directions: The statements below tell how some students feel about SPECIFIC ISSUES IN SCIENCE. Read each statement and then CIRCLE the choice which best describes how you feel about it.

Here is an example about skating which shows how to mark your answer if you disagree with the statement.

SKATING IS A WASTE OF TIME.

Strongly Disagree 1 [✓ Disagree 2] Can't Decide 3 Agree 4 Strongly Agree 5

Please be as honest as possible in rating each statement. There is no correct answer. Do not spend too much time on any one statement.

FORM 12Y

1. STUDENTS SHOULD LEARN HOW TO USE COMPUTERS.

Strongly Disagree .01 Disagree .11 Can't Decide .10 Agree .61 Strongly Agree .16

2. SCIENTISTS SHOULD DO MORE RESEARCH ABOUT CREATING LIFE IN THE LABORATORY.

Strongly Disagree .09 Disagree .31 Can't Decide .33 Agree .25 Strongly Agree .02

3. ELECTRICAL GENERATORS POWERED BY COAL AND OIL CAUSE LESS POLLUTION THAN NUCLEAR PLANTS.

Strongly Disagree .10 Disagree .33 Can't Decide .26 Agree .24 Strongly Agree .06

4. HIGHWAY SPEED LIMITS SHOULD BE MADE LOWER SO THAT WE CAN SAVE GASOLINE.

Strongly Disagree .15 Disagree .55 Can't Decide .10 Agree .18 Strongly Agree .02

(CONT'D) SPECIFIC ISSUES (12Y)

5. SCIENTISTS SHOULD CONDUCT EXPERIMENTS ON ANIMALS IF THEY THINK PEOPLE WILL BE HELPED.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.07	.13	.13	.55	.12

6. WE CAN USE ALL THE NATURAL GAS, OIL AND GASOLINE WE NEED NOW BECAUSE FUTURE GENERATIONS WILL FIND NEW FORMS OF ENERGY.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.27	.53	.09	.10	.02

7. WE SHOULD GET BACK TO A SIMPLER WAY OF LIFE BY GETTING RID OF ALL THIS TECHNOLOGY.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.26	.44	.13	.13	.04

8. FACTORIES SHOULD BE REQUIRED TO REDUCE SMOKE POLLUTION EVEN IF PRICES GO UP.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.01	.06	.10	.50	.32

9. PEOPLE SHOULD BE MORE CRITICAL OF COMPANIES' CLAIMS THAT THEIR MEDICAL DRUGS ARE SAFE.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.01	.03	.15	.56	.25

10. FARMERS AND RANCHERS SHOULD BE ABLE TO USE ANY CHEMICAL SPRAYS THEY THINK ARE NECESSARY.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.41	.47	.05	.06	.01

METHODS OF SCIENCE (12Y)

1. SCIENTIFIC FACTS ARE USUALLY TRUE.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.02	.22	.10	.60	.06

2. SCIENTIFIC IDEAS CAN USUALLY BE PROVEN BY EXPERIMENT.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.01	.09	.06	.76	.07

3. SCIENCE IS GETTING CLOSER AND CLOSER TO THE TRUTH.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.03	.15	.30	.47	.04

4. MOST SCIENTIFIC FINDINGS HAVE BEEN A BLOW AGAINST COMMON SENSE.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.05	.45	.27	.21	.01

(CONT'D) METHODS OF SCIENCE (12Y)

5. LEARNING SCIENCE MAKES YOU MORE BROADMINDED.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.02	.16	.13	.57	.12

6. SCIENTISTS MUST BE WILLING TO CHANGE THEIR IDEAS WHEN NEW INFORMATION BECOMES KNOWN.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.01	.05	.04	.65	.25

7. A USEFUL SCIENTIFIC THEORY MAY NOT BE ENTIRELY CORRECT, BUT IT IS THE BEST IDEA SCIENTISTS HAVE BEEN ABLE TO DEVELOP.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.01	.09	.19	.64	.06

8. WHEN TRADITIONAL BELIEFS ARE IN CONFLICT WITH SCIENTIFIC DISCOVERIES, IT IS BETTER TO ACCEPT THE TRADITIONAL BELIEFS.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.16	.50	.22	.10	.02

9. SCIENCE IS A WAY OF THINKING.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.03	.17	.13	.59	.09

10. ONE OF THE IMPORTANT JOBS OF A SCIENTIST IS TO REPORT EXACTLY WHAT HIS SENSES TELL HIM.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.06	.33	.16	.39	.07

CAREERS IN SCIENCE (12Y)

1. GOING INTO SCIENCE AS A CAREER WOULD BE WELL WORTH THE TIME AND EFFORT REQUIRED.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.04	.20	.23	.41	.12

2. A CAREER IN SCIENCE WOULD BE IDEALLY SUITED TO GIRLS.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.09	.30	.34	.24	.03

3. A CAREER IN SCIENCE WOULD BE VERY SATISFYING.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.04	.21	.28	.41	.07

(CONT'D) CAREERS IN SCIENCE (12Y)

4. A SCIENTIFIC CAREER MIGHT BE ALL RIGHT FOR SOME PEOPLE BUT NOT FOR ME.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.06	.19	.13	.33	.29

5. SCIENCE AS A CAREER WOULD NOT INTEREST ME BECAUSE THE WORK IS TOO HARD.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.15	.56	.09	.16	.04

6. SCIENTIFIC WORK DOES NOT INTEREST ME.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.13	.36	.08	.26	.17

7. WORKING AS A SCIENTIST WOULD BE A DESIRABLE OCCUPATION.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.08	.31	.24	.31	.06

8. A CAREER IN SCIENCE WOULD BE IDEALLY SUITED TO BOYS.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.01	.06	.10	.51	.32

9. I WOULD BE WILLING TO TAKE A JOB RELATED TO SCIENTIFIC WORK.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.08	.24	.19	.41	.07

10. SCIENCE WOULD BE TERRIBLE AS A LIFE'S CAREER.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.12	.48	.21	.15	.05

11. I WOULD BE SATISFIED TO SPEND MY LIFE AS A SCIENTIST.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.16	.43	.21	.16	.04

12. SCIENCE WORK WOULD GIVE A GREAT DEAL OF PLEASURE.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.07	.26	.30	.32	.04

13. IT IS SILLY FOR GIRLS TO WASTE TIME STUDYING FOR A SCIENTIFIC CAREER.

Strongly Disagree	Disagree	Can't Decide	Agree	Strongly Agree
.03	.14	.30	.49	.06

SECOND ASSESSMENT OF SCIENCE

GRADE 12 1982

Organization of Test Items

Objective		Test Items*	Page No.
	DOMAIN 1: SCIENCE PROCESSES		
1.1	Interpret Data	X: 4,5,14,15 Y: 5,6,8,11,22,23	3-7
1.2	Identify and Control Variables	X: 7,10,16,19,30,33,35 Y: 2,9,14,21,28	8-11
	DOMAIN 2: KNOWLEDGE: RECALL AND UNDERSTAND		
2.1	Major Concepts, Basic Principles, Laws and Supporting Facts of Science	X: 2,9,17,18,22,23,26, 27,31 Y: 1,4,7,18,20,27,33	12-17
2.2	Applications of Science (Technology) and the Nature of Science	X: 1,13,20,21 Y: 29,34	18-19
2.3	Safety Procedures	X: 3,12,29,32 Y: 16,17,24,35	20-22
	DOMAIN 3: HIGHER LEVEL THINKING		
3.1	Evaluate Evidence for Conclusions	X: 6,8 Y: 3,15,26,31	23-25
3.2	Solve Abstract Problems	X: 11,24,25,28,34 Y: 10,12,13,19,25, 30,32	26-30

* X = Test Booklet X
Y = Test Booklet Y

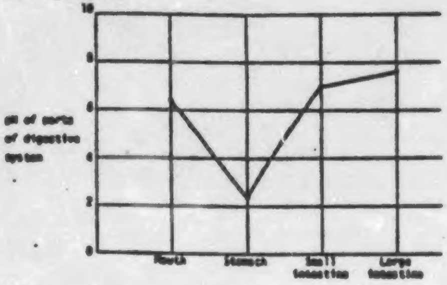
DOMAIN 1: SCIENCE PROCESSES

OBJECTIVE 1.1: INTERPRET DATA

grade 10 12

Use the information below when answering questions 4 and 5.

ENZYME	MOST ACTIVE pH LEVEL
amylase	6.2
pepsin	2.2
maltase	7.0
lactase	5.7



1.1.01 X/04 Amylase should be most active in the

S

		p-value	
A. mouth.	☒	47	55
B. stomach.	☐	5	5
C. small intestine.	☐	7	6
D. large intestine.	☐	29	23
E. I don't know.	☐	12	12

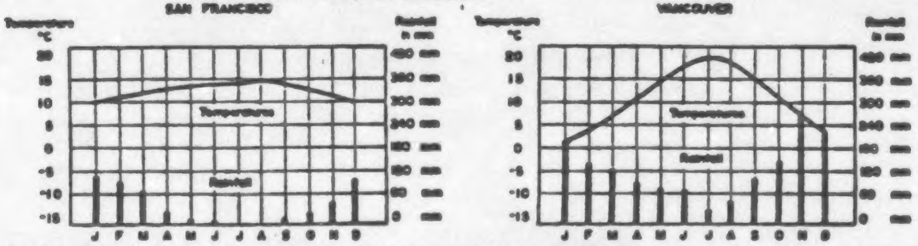
1.1.02 X/05 Both maltase and lactase are active in the small intestine. The information given above would lead one to believe that

W

		p-value	
A. maltase is most active in the part nearest the stomach.	☐	21	21
B. lactase is most active in the part nearest the stomach.	☒	14	22
C. both are equally and very active in the part nearest the stomach.	☐	17	14
D. both are equally and very active in all the same places.	☐	8	8
E. I don't know.	☐	40	35

Refer to the graphs below when answering questions 14 and 15.

The CURVES at the top of the two graphs represent average monthly TEMPERATURES for San Francisco and Vancouver. The BARS on the bottom of the graphs represent average monthly RAINFALL for the two cities. The letters at the bottom of the graphs stand for the months from January to December.



1.1.03 X/14 From the temperature data it can be determined that

M

		p-value	
A. both cities have the same average monthly temperature increases in winter.	☐	5	4
B. average monthly temperatures reach a peak in summer in San Francisco, but not in Vancouver.	☐	11	8
C. both cities have highest average temperatures in summer.	☒	54	66
D. average monthly temperatures rise in winter in Vancouver, but drop in San Francisco	☐	15	10
E. I don't know	☐	15	12

1.1.04 X/15 On the basis of the graphs, what is the relationship between temperature and rainfall in these cities?

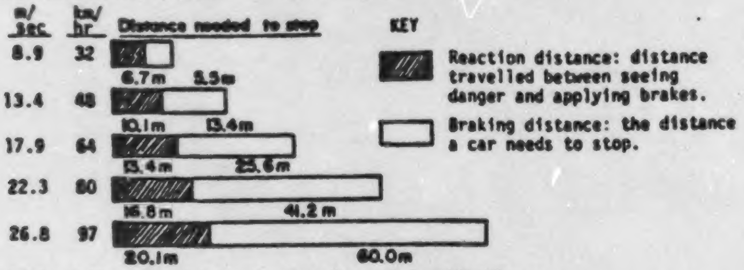
VS

		p-value	
A. Rainfall increases as temperature increases.	☐	9	7
B. Rainfall decreases as temperature increases.	☒	70	77
C. Rainfall decreases as temperature decreases.	☐	5	5
D. Rainfall and temperature are independent.	☐	13	8
E. I don't know.	☐	4	4

OBJECTIVE 1.1: INTERPRET DATA

grade
10 12

Use the following graph when answering questions 5 and 6.



1.1.05 Y/05 Which of the following conclusions is most justified?

M

p-value

A. The higher one's speed, the longer it takes to react . . . . ☐ 24 20
B. As one doubles the speed, the total distance necessary for stopping becomes twice as great. . . . . ☐ 17 15
C. For the speeds given, the greater the speed - the greater the reaction distance ☒ 32 40
D. The braking distance is always greater than the distance travelled in reacting to the danger signal . . . . ☐ 14 15
E. I don't know . . . . ☐ 13 9

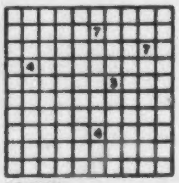
1.1.06 Y/06 From the chart you could conclude that the reaction time of the average driver is

M

p-value

A. less than one second. . . . . ☒ 24 31
B. one second. . . . . ☐ 9 6
C. a little more than one second. . . . . ☐ 21 21
D. much more than one second. . . . . ☐ 27 24
E. I don't know. . . . . ☐ 20 19

A student wished to find out how many ants there were in one square metre of his lawn. He divided one square metre up into 100 equal patches and counted the ants in five of the patches. He obtained the numbers of 3, 4, 4, 7 and 7.



1.1.07 Y/08 What is the BEST estimate for the total number of ants on one square metre?

M

p-value

A. 400 . . . . ☐ 8 5
B. 500 . . . . ☒ 46 56
C. 700 . . . . ☐ 5 3
D. None of the above . . . . ☐ 27 22
E. I don't know . . . . ☐ 15 14

The treeline is the highest altitude at which trees can grow. The following table relates treeline to distance from the equator.

Distance from Equator	Treeline
1000 km	4000 m
2500 km	3500 m
5000 km	3000 m
6500 km	1500 m

1.1.08 Y/11 According to the table above, the farther you are from the equator

VS

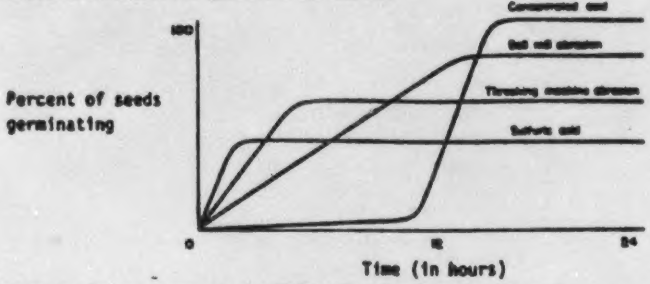
p-value

A. the higher the treeline. . . . . ☐ 8 5
B. the lower the treeline. . . . . ☒ 74 80
C. the taller the trees. . . . . ☐ 3 1
D. the smaller the trees. . . . . ☐ 9 9
E. I don't know. . . . . ☐ 6 5

OBJECTIVE 1.1: INTERPRET DATA

grade
10 12

Use the graph below when answering questions 22 and 23.



1.1.09 Y/22 Which ONE treatment of seeds seems to be MOST effective for starting germination in a maximum number of seeds (i.e., for breaking dormancy)?

M

		p-value	
A. Concentrated acid	☒	42	44
B. Ball mill abrasion	☐	15	15
C. Threshing machine abrasion	☐	8	6
D. Sulfuric acid	☐	16	20
E. I don't know	☐	19	15

1.1.10 Y/23 If treatment were given for only six hours, which ONE would be MOST effective for starting germination in a maximum number of seeds (i.e., for breaking dormancy)?

S

		p-value	
A. Concentrated acid	☐	8	4
B. Ball mill abrasion	☐	9	7
C. Threshing machine abrasion	☒	49	59
D. Sulfuric acid	☐	17	14
E. I don't know	☐	17	16

OBJECTIVE 1.2: IDENTIFY AND CONTROL VARIABLES

1.2.01 X/07 Some chickens lay an egg almost every day. Other chickens produce very few eggs. A study is planned to examine factors that might affect the number of eggs produced by chickens. Which of the following is NOT a suitable hypothesis for the study?

M

		p-value	
A. More eggs are produced by chickens that receive more hours of light.	☐	8	8
B. The larger the cage for chickens, the more eggs they will produce.	☐	24	19
C. The more eggs produced by chickens, the more weight they lose.	☒	35	44
D. The more protein there is in the feed, the more eggs are produced.	☐	22	19
E. I don't know.	☐	12	9

1.2.02 X/10 If you were given a strange new wild animal that looked something like a very large cat, which would be the BEST single SCIENTIFIC way to find out what it liked best to eat?

S

		p-value	
A. Give it plenty of each kind of food which you think it might like and see how much of each it eats.	☒	62	65
B. Give it one kind of meat and see how much it eats.	☐	9	9
C. Give it fruit and vegetables and see how much it eats.	☐	1	1
D. Give it a special cat family food and see how much it eats.	☐	19	18
E. I don't know.	☐	9	7

1.2.03 X/16 Which variable below must be held constant if you want to find out which of two kinds of cloth absorbs water better?

S

		p-value	
A. The length of time the cloths are in water	☒	46	56
B. The kind of cloth	☐	25	23
C. The colour of the cloth	☐	2	1
D. The height that the water rises in each cloth	☐	20	15
E. I don't know	☐	6	4

OBJECTIVE 1.2: IDENTIFY AND CONTROL VARIABLES

1.2.04 X/19 A group of students conducted an experiment to determine the effect of heating on the germination of sunflower seeds. Which of the variables listed below is LEAST important to control in this experiment?

S

		grade 10	grade 12
		p-value	
A. The degree to which the seeds are heated	☐	9	7
B. The amount of moisture	☐	6	4
C. The type of soil used	☐	13	12
D. The size of container used	☒	65	69
E. I don't know	☐	8	6

1.2.05 X/30 Which ONE of these would make the water in a small region of the ocean MORE salty?

S

		p-value	
A. Water from a river running into it	☐	6	6
B. Evaporation of a lot of the water	☒	60	67
C. Melting an iceberg in the region	☐	9	7
D. Heavy rainfall over the region	☐	14	10
E. I don't know	☐	11	10

1.2.06 X/33 In a teaching experiment fifty students were divided at random into two equal groups. One group was taught using igneous rocks; the other group used sedimentary rocks. Both classes were held in the afternoon. In the experiment, the factor which was NOT held constant was

M

		p-value	
A. the size of the groups.	☐	8	8
B. the topic of rocks.	☐	22	20
C. the type of rocks.	☒	42	48
D. the time of day of the classes.	☐	16	14
E. I don't know.	☐	13	10

1.2.07 X/35 Which of the following pieces of information is NOT needed for choosing an electric motor to drive an elevator?

S

		p-value	
A. The required acceleration of the elevator	☐	19	19
B. The maximum weight of the passengers	☐	12	10
C. The height of the building	☒	43	47
D. The voltage of the electric supply	☐	11	11
F. [illegible]on't know	☐	15	13

1.2.08 Y/02 The influence of two new drugs on Grade 11 students' ability to learn is to be tested. Which of the variables listed below would be MOST important to control in the experiments?

ST

		p-value	
A. The location of the experiment	☐	2	2
B. The time of day the drugs are given	☐	3	2
C. The amount of each drug taken	☒	82	85
D. The age of the students	☐	4	5
E. I don't know	☐	6	5

1.2.09 Y/09 Salt may be added to a solution until it will float an egg. This statement is based on the assumption that all eggs have

M

		p-value	
A. equal weight.	☐	14	11
B. equal volume.	☐	13	11
C. equal density.	☒	40	50
D. about the same shape.	☐	16	11
E. I don't know.	☐	18	16

OBJECTIVE 1.2: IDENTIFY AND CONTROL VARIABLES

grade
10 12

EIGHT bean seeds were germinated, then divided into FOUR groups of two seeds each. One group of two seeds was grown under RED light, another under YELLOW light, another under BLUE light and the fourth under ordinary WHITE light. At the end of two weeks, each group of plants was measured to see which group of plants had grown the most.

1.2.10 Y/14 This experiment could best be improved by

W

		p-value	
A. giving more water to the plants grown under red light.	☐	5	3
B. increasing the number of seeds grown in each of the four groups.	☒	21	29
C. growing plants also under purple light	☐	3	3
D. measuring the growth of the plants each day.	☐	52	50
E. I don't know	☐	18	15

1.2.11 Y/21 Sue wants to find out what might affect the length of bean seedlings. She places a bean wrapped in moist tissue paper in each of ten identical test tubes. She puts five tubes on a rack in a sunny window. She puts the other five tubes on a rack in a dark refrigerator. She measures the lengths of the bean seedlings in each group after one week. Which of the following variables might affect the length of the seedlings to answer her question?

S

		p-value	
A. Light and the amount of time	☐	9	7
B. Light and temperature.	☒	51	58
C. Moisture and the length of the test tubes.	☐	6	5
D. Temperature and moisture	☐	27	24
E. I don't know	☐	7	8

1.2.12 Y/28 A farmer noticed that on two occasions when he heard an owl hooting in the evening, it rained that night. He concluded that owls hoot before it rains. How would you describe his conclusion.

M

		p-value	
A. Nothing was wrong with his conclusion.	☐	6	6
B. His conclusion was based on insufficient data.	☒	55	63
C. Conclusions of this type can never be scientific because there is no way to gather sufficient data	☐	28	23
D. To complete the experiment, he needs to record the amount of rainfall.	☐	5	2
E. I don't know	☐	6	5

DOMAIN 2: KNOWLEDGE: RECALL AND UNDERSTAND

OBJECTIVE 2.1: MAJOR CONCEPTS, BASIC PRINCIPLES, LAWS AND SUPPORTING FACTS OF SCIENCE

2.1.01 X/02 If a neutral atom loses an electron, which of the following is formed?

VS

		p-value	
A. A gas	☐	4	4
B. An ion	☒	40	47
C. An acid	☐	1	1
D. A radical	☐	8	7
E. A molecule	☐	16	14
F. I don't know	☐	30	27

2.1.02 X/09 A fossil of an ocean fish was found in a rock outcrop on a mountain. This probably means that

M

		p-value	
A. fish once lived on the mountain.	☐	3	2
B. the relative humidity was once very high.	☐	9	7
C. the mountain was raised up after the fish died.	☒	29	43
D. fish used to be amphibians like toads and frogs.	☐	7	5
E. the fossil fish was probably carried to the mountain by a great flood.	☐	46	38
F. I don't know.	☐	6	5

2.1.03 X/17 In which of the following ways does a sample of steam differ from a sample of ice? The molecules of steam

S

		p-value	
A. move more slowly.	☐	3	3
B. are smaller.	☐	3	3
C. contain less energy.	☐	3	2
D. are closer together.	☐	11	9
E. are farther apart.	☒	69	68
F. I don't know.	☐	11	15

OBJECTIVE 2.1: MAJOR CONCEPTS, BASIC PRINCIPLES, LAWS AND SUPPORTING FACTS OF SCIENCE

2.1.04 X/15 The human embryo normally develops in the

M

		grade 10 p-value	grade 12 p-value
A. abdominal cavity.	☐	9	9
B. ovary.	☐	23	18
C. oviduct.	☐	3	2
D. uterus.	☒	37	54
E. vagina.	☐	7	4
F. I don't know.	☐	20	12

2.1.05 X/22 The food which would provide the most protein for building and repairing body tissues is

M

		p-value	
A. green beans.	☐	20	17
B. boiled potatoes.	☐	5	3
C. oatmeal.	☐	8	6
D. lean meat.	☒	56	64
E. I don't know.	☐	12	10

2.1.06 X/23 A stream which is deepening its valley in an area previously eroded is considered to be

S

		p-value	
A. old.	☐	31	24
B. mature.	☐	11	15
C. rejuvenated.	☒	25	33
D. young.	☐	13	11
E. I don't know.	☐	20	17

2.1.07 X/26 In terms of the theory of natural selection, why do giraffes have such long necks?

S

		p-value	
A. Stretching to get food in high trees has made their necks longer.	☐	9	12
B. There is something inside of giraffes which keeps making longer necks	☐	4	2
C. Giraffe food contained vitamins which caused the vertebrae to lengthen.	☐	9	5
D. Giraffe necks have gotten longer and longer as time has gone on, but nobody has any idea why this is.	☐	19	12
E. Giraffes born with the longest necks have been able to stay alive when food was scarce and have passed this trait on to their offspring.	☒	42	55
F. I don't know.	☐	17	14

2.1.08 X/27 The particles most directly involved in forming chemical bonds are

S

		p-value	
A. electrons.	☒	49	51
B. neutrons.	☐	9	9
C. photons.	☐	3	2
D. positrons.	☐	3	1
E. protons.	☐	15	12
F. I don't know.	☐	20	25

2.1.09 X/31 Which of these concepts can be used to explain why a driver who is not wearing a seat belt may be thrown through the windshield if his car stops suddenly?

S

		p-value	
A. Buoyancy	☐	9	8
B. Friction	☐	9	9
C. Potential energy	☐	18	20
D. Inertia	☒	39	44
E. Mechanical advantage	☐	13	6
F. I don't know	☐	12	12

OBJECTIVE 2.1: MAJOR CONCEPTS, BASIC PRINCIPLES, LAWS AND SUPPORTING FACTS OF SCIENCE

2.1.10 Y/01 Heating a mixture of powdered iron and sulfur will result in the formation of

S

		grade 10 p-value	12
A. a single element.	☐	5	5
B. two other elements.	☐	5	3
C. a solution.	☐	15	8
D. an alloy.	☐	9	8
E. a compound.	☒	42	46
F. I don't know.	☐	24	30

2.1.11 Y/0[illegible] What is the main way that sweating helps your body?

S

		p-value	
A. It helps cool your body.	☒	62	65
B. It gets rid of the salt in your body.	☐	30	29
C. It keeps you from catching cold.	☐	0	1
D. It keeps your skin moist.	☐	4	3
E. I don't know.	☐	4	3

2.1.12 Y/07 In hot climates the advantage of buildings with white surfaces is that white surfaces effectively

S

		p-value	
A. reflect light.	☒	74	76
B. diffract light.	☐	4	5
C. absorb light.	☐	5	3
D. refract light.	☐	13	13
E. I don't know.	☐	3	3

2.1.13 Y/18 Green plants are important to animals because the plants

M

		p-value	
A. consume both food and oxygen.	☐	10	6
B. consume food and give off oxygen.	☐	10	7
C. consume food and give off carbon dioxide.	☐	4	3
D. produce food and give off oxygen.	☒	57	63
E. produce food and give off carbon dioxide.	☐	13	14
F. I don't know.	☐	5	6

2.1.14 Y/20 A certain machine is said to be 50% efficient. What does this mean?

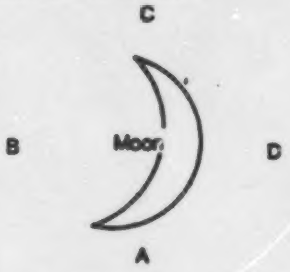
S

		p-value	
A. The machine is not useful for the task performed.	☐	6	6
B. The machine operates with no loss of energy 50% of the time.	☐	8	9
C. Only 50% of the work put into the machine is returned as useful work done.	☒	43	50
D. 50% of the energy put into the machine is destroyed.	☐	13	10
E. Only 50% of the work put into the machine can be measured as energy.	☐	17	12
F. I don't know.	☐	13	12

OBJECTIVE 2.1: MAJOR CONCEPTS, BASIC PRINCIPLES, LAWS AND SUPPORTING FACTS OF SCIENCE

grade
10 12

Look at the diagram below.



2.1.15 Y/27 The sun would be located at position

M

p-value

A. .... ☐ 8 8
B. .... ☐ 22 20
C. .... ☐ 9 7
D. .... ☒ 48 47
E. I don't know. .... ☐ 13 19

2.1.16 Y/33 Think of diving into the ocean near the Equator. As you go deeper, the water gets colder because

M

p-value

A. the saltiest water is always coldest and sinks to the bottom. .... ☐ 3 4
B. warm water is lighter than cold water, and stays on top. .... ☒ 31 32
C. the deeper water is not in contact with the air. .... ☐ 56 51
D. volcanic activity warms only the upper layers of the water. .... ☐ 3 2
E. I don't know. .... ☐ 7 11

OBJECTIVE 2.2: APPLICATIONS OF SCIENCE (TECHNOLOGY) AND THE NATURE OF SCIENCE

2.2.01 X/01 About which of these subjects do scientists know everything?

M

p-value

A. No topic .... ☒ 46 63
B. Trees .... ☐ 12 10
C. Tooth decay .... ☐ 6 5
D. Space .... ☐ 25 13
E. I don't know .... ☐ 10 8

2.2.02 X/13 A famous scientist once wrote: "Being well informed about science is not the same thing as understanding science". From this quotation it follows that

VS

p-value

A. one acquires an understanding of science by learning the laws and principles which are found in the science textbooks. .... ☐ 8 6
B. understanding science means more than learning the facts and principles of science. .... ☒ 59 67
C. the only way that people can understand science is through a greater presentation of scientific information. .... ☐ 11 10
D. knowing a great deal about science is actually a handicap to really understanding science. .... ☐ 10 7
E. I don't know. .... ☐ 12 10

2.2.03 X/20 Which ONE of the following is a THEORY?

S

p-value

A. All substances on the planet Earth consist of protons, electrons and neutrons. .... ☒ 54 63
B. A metre contains 100 cm. .... ☐ 5 4
C. Light travels at 300,000 m per second. .... ☐ 13 8
D. The Earth is 150,000,000 km from the sun. .... ☐ 18 14
E. I don't know. .... ☐ 10 11

OBJECTIVE 2.2: APPLICATIONS OF SCIENCE (TECHNOLOGY) AND THE NATURE OF SCIENCE

grade
10 12

2.2.04 X/21 Which of the following is an activity of science rather than technology?

M

			p-value	
A.	Curing an illness	☐	32	31
B.	Explaining how a delta forms	☒	30	33
C.	Preserving food	☐	15	14
D.	Communicating information by computer	☐	11	11
E.	I don't know	☐	12	11

2.2.05 Y/29 Which of the following represents the LOWEST degree of certainty?

S

			p-value	
A.	Conclusion	☐	11	11
B.	Principle	☐	20	16
C.	Hypothesis	☒	46	57
D.	Fact	☐	10	6
E.	I don't know	☐	13	10

2.2.06 Y/34 In his research a scientist discovers a powerful chemical which causes people to obey blindly the orders of anyone. One litre of this chemical is enough to turn everyone in a city into a human robot. It can easily be put into the water supply of a city. How should this research be judged?

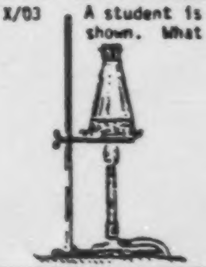
S

			p-value	
A.	It is not wrong for the scientist to discover the chemical but it would be wrong to use it.	☒	70	72
B.	It is not wrong for the scientist to discover the chemical and it would not be wrong to use it.	☐	10	8
C.	It was wrong for the scientist to discover the chemical.	☐	10	10
D.	I don't know.	☐	10	10

OBJECTIVE 2.3: SAFETY PROCEDURES

2.3.01 X/03 A student is boiling water in a stoppered glass jar or flask, as shown. What precaution would you take if you saw this?

W



			p-value	
A.	Immediately turn off the gas to the burner.	☒	54	57
B.	Make sure the stopper is in tightly so the steam cannot escape.	☐	4	3
C.	Make sure the gas line does not become disconnected.	☐	7	6
D.	Keep the burner turned down to low heat.	☐	30	29
E.	I don't know.	☐	5	5

2.3.02 X/12 Which of the following substances must be kept away from sparks or open flames?

S

			p-value	
A.	Hydrochloric and sulfuric acid	☐	15	15
B.	Sodium hydroxide and potassium hydroxide	☐	11	7
C.	Alcohol and ether	☒	67	71
D.	Tin and lead	☐	1	1
E.	I don't know	☐	5	5

2.3.03 X/29 The purpose of a fuse or circuit breaker is to

M

			p-value	
A.	turn lights on and off.	☐	5	5
B.	protect circuits from carrying too much electricity.	☒	53	55
C.	protect people from getting electric shocks.	☐	8	5
D.	save electricity from being wasted.	☐	4	2
E.	regulate the number of volts in the circuit.	☐	21	28
F.	I don't know.	☐	8	5

OBJECTIVE 2.3: SAFETY PROCEDURES

grade
10 12

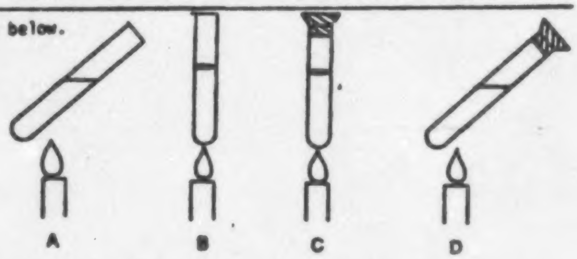
2.3.04 X/32 You have been given the assignment to identify which one of five white powders is table salt. To test, you should do ALL of the following EXCEPT

M

p-value

A. dissolve some of the powder in water and test for each ion. ☐ 8 8
B. taste the white powders. ☒ 56 62
C. compare the solubility of this powder with that of salt. ☐ 9 7
D. examine the crystals under a microscope: salt has cubic crystals. ☐ 19 17
E. I don't know. ☐ 7 5

2.3.05 Y/16 Look at the diagrams below.



Which is the correct method of heating a liquid in a test tube?

M

p-value

A. ☒ 66 67
B. ☐ 13 14
C. ☐ 4 3
D. ☐ 15 13
E. I don't know ☐ 2 5

2.3.06 Y/17 When diluting an acid, which is the correct procedure?

W

p-value

A. Add water to acid. ☐ 30 30
B. Add acid to water. ☒ 24 25
C. Add water to one-half of the acid and then add the remainder of the acid. ☐ 11 10
D. Pour acid and water together into an empty beaker. ☐ 13 12
E. I don't know. ☐ 23 23

2.3.07 Y/24 What is the safe way to smell odours?

S

p-value

A. Wear a gas mask and keep far from the source of the odours. ☐ 4 4
B. Waft the gas toward your nose with your hand. ☒ 66 64
C. Leave the area, because you should never deliberately smell chemicals. ☐ 20 19
D. Bring the container giving odours close to your nose. ☐ 4 4
E. I don't know. ☐ 6 8

2.3.08 Y/35 You are going to light a bunsen burner. What should you do just before you turn on the gas?

M

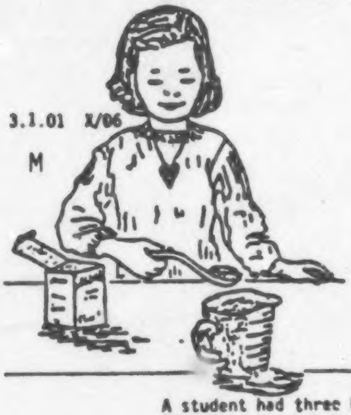
p-value

A. Guess at the position at which the air control should be open for proper burning. ☐ 18 16
B. Close the air control completely. ☒ 41 44
C. Leave the air control as you found it, since it probably is in the correct position. ☐ 5 4
D. Open the air control completely. ☐ 27 25
E. I don't know. ☐ 9 11

OBJECTIVE 3.1: EVALUATE EVIDENCE FOR CONCLUSIONS

grade
10 12

Look at this picture.



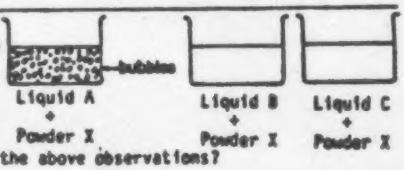
3.1.01 X/06 What observation can you make from it?

M

p-value

A. A person is holding powder from the box in the spoon. ☐ 26 22
B. A person is stirring baking soda into water. . . . . ☐ 11 11
C. A person is taking something from the measuring cup on the table. . . . . ☐ 8 7
D. A person is holding a spoon with something in the spoon. . . . . ☒ 53 58
E. I don't know. . . . . ☐ 2 2

A student had three beakers containing liquids. To each beaker he added 10g of Powder X. The results are shown below.



3.1.02 X/08 Which inference is best supported by the above observations?

ST

p-value

A. Liquids A and C are the same. . . . . ☐ 4 2
B. Liquids A and B are NOT the same. . . . . ☒ 83 86
C. Liquids A, B and C are all the same. . . . . ☐ 2 2
D. Liquids B and C are NOT the same. . . . . ☐ 4 4
E. I don't know. . . . . ☐ 6 5

A poem entitled "The Ancient Mariner" contains the lines:

> "The sun now rose upon the right
> Out of the sea came he,
> Still hid in mist, and on the left
> Went down into the sea."

3.1.03 Y/03 In which direction was the Ancient Mariner sailing?

W

p-value

A. North . . . . ☒ 42 48
B. South . . . . ☐ 16 14
C. East . . . . ☐ 13 12
D. West . . . . ☐ 19 16
E. I don't know . . . . ☐ 11 10

Two boys did the same piece of work (carrying 50 concrete blocks up a short flight of steps). Their pulse rates were taken just before and after doing this work. The beats per minute were:

Boy 1	Before: 68	After: 92
Boy 2	Before: 74	After: 100

3.1.04 Y/15 Which one of the following statements is CERTAINLY TRUE on the basis of these measurements?

M

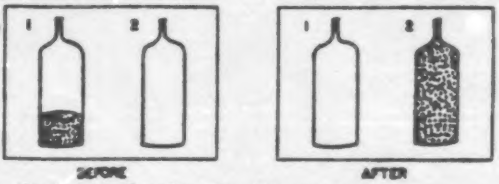
p-value

A. The measurements are insufficient to decide whose heart is the more powerful or who did the work more quickly. . . . . ☒ 38 50
B. Boy 1 has a more powerful heart than Boy 2. . . . . ☐ 33 [illegible]
C. Boy 1 has a less powerful heart than Boy 2. . . . . ☐ 15 9
D. Boy 1 did the work more quickly than Boy 2. . . . . ☐ 4 5
E. I don't know. . . . . ☐ 10 8

OBJECTIVE 3.1: EVALUATE EVIDENCE FOR CONCLUSIONS

grade
10 12

In the diagrams below, Bottles 1 and 2 are exactly alike. HOWEVER, THEY MAY BE AT DIFFERENT TEMPERATURES. Bottle 1 contains a substance which is transferred to Bottle 2 without any loss.



3.1.05 Y/26 Which one of the following is the best explanation of what you see in the diagrams?

S

p-value

A. In Bottle 1, the substance is a gas and in Bottle 2 the substance is a liquid. . . . . ☐ 9 7

B. In Bottle 1, the substance is a liquid and in Bottle 2 the substance is a gas. . . . . ☒ 49 51

C. In Bottle 1, the substance is a solid and in Bottle 2 the substance is a liquid. . . . . ☐ 9 8

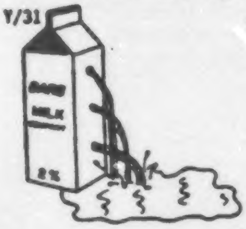
D. In Bottle 1, the substance has less mass than in Bottle 2. . . . . ☐ 11 10

E. I don't know. . . . . ☐ 22 24

Look at the figure below.

3.1.06 Y/31

S



This figure demonstrates that

p-value

A. the deeper the liquid, the greater the liquid pressure. . . . . ☒ 50 57

B. liquid moves at different speeds . . . . ☐ 5 4

C. air pressure causes the liquid to shoot out . . . . ☐ 18 15

D. the deeper the liquid, the greater the air pressure . . . ☐ 19 16

E. I don't know. . . . . ☐ 8 8

OBJECTIVE 3.2: SOLVE ABSTRACT PROBLEMS

3.2.01 X/12 The fact that man's system of capillaries consists of numerous vessels with very small diameters rather than a few larger vessels is advantageous because

S

p-value

A. a smaller volume of blood comes into contact with the cells. . . . . ☐ 3 2

B. the blood is distributed more uniformly through the tissues. . . . . ☒ 41 50

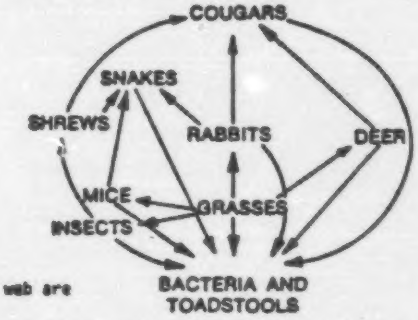
C. the heart can pump blood through the body with less effort . . . . ☐ 12 10

D. the blood pressure in the arteries is decreased. . . . . ☐ 9 6

E. the rate of blood flow is increased. . . . . ☐ 6 5

F. I don't know . . . . ☐ 29 26

Look at the food web below.



3.2.02 X/24 The only producers shown in the food web are

M

p-value

A. grasses. . . . . ☒ 36 48

B. toadstools. . . . . ☐ 38 33

C. mice. . . . . ☐ 1 1

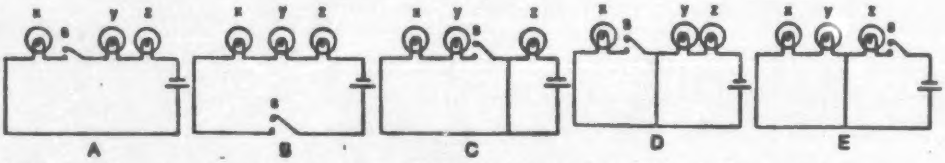
D. deer. . . . . ☐ 4 3

E. I don't know. . . . . ☐ 20 14

OBJECTIVE 3.2: SOLVE ABSTRACT PROBLEMS

grade
10 12

In the diagrams below, X, Y and Z represent three lamps in a circuit, which also includes a battery and a switch S.



3.2.03 X/25 When the switch is open, X fails to light while Y and Z do light. Which one of the following circuits is it?

S

		p-value	
A.	☐	15	16
B.	☐	5	3
C	☐	6	4
D.	☒	57	58
E.	☐	3	3
F. I don't know	☐	14	15

3.2.04 X/28 When some pink food colouring is dissolved in water, the water turns pink. The best explanation for this is that all

S

		p-value	
A. substances are composed of atoms.	☐	9	6
B. substances are composed of molecules which move.	☒	41	45
C. molecules are very close together.	☐	8	6
D. molecules are composed of atoms which move.	☐	20	16
E. I don't know.	☐	22	26

3.2.05 X/34 Scientists are skeptical that Earth has been visited by beings from outside the solar system because

W

		p-value	
A. there is no life anywhere in the Universe except on Earth.	☐	7	5
B. the distances between stars are enormous.	☒	26	31
C. only crackpots believe in such nonsense.	☐	4	3
D. few places outside the solar system can support life.	☐	54	52
E. I don't know.	☐	8	9

3.2.06 Y/10 A man whose blood type is OA marries a woman whose blood type is OB. Their offspring could not have which of the following blood types?

S

		p-value	
A. AA	☒	39	51
B. AB	☐	14	10
C. OA	☐	5	2
D. OB	☐	3	2
E. OO	☐	17	14
F. I don't know	☐	20	18

3.2.07 Y/12 Atmospheric carbon dioxide is believed to be increasing due to

W

		p-value	
A. decreased carbon dioxide fixation by green plants.	☐	16	14
B. increased release from volcanoes.	☐	4	5
C. increased burning of fossil fuels.	☒	30	37
D. cutting down of too many trees.	☐	20	20
E. I don't know.	☐	30	25

OBJECTIVE 3.2: SOLVE ABSTRACT PROBLEMS

3.2.08 Y/13 Which of the following would be the safest place to be during a thunderstorm?

M

		grade 10 p-value	grade 12 p-value
A. Near a lake	☐	7	7
B. Under a tree	☐	7	7
C. In an open field	☐	39	37
D. In an automobile	☒	41	42
E. I don't know	☐	5	7

3.2.09 Y/19 If the Earth's axis were to be tipped at an angle of 10° instead of 23°, which of the following would be true?

S

		p-value 10	p-value 12
A. The year would be longer than at present.	☐	7	4
B. There would be only half as many hours of daylight in a year as at present.	☐	12	10
C. We would be able to see both sides of the Moon.	☐	2	1
D. The Moon would appear to be motionless rather than appearing to move in the sky.	☐	2	2
E. None of the above would be true.	☒	38	40
F. I don't know	☐	39	42

3.2.10 Y/25 When 2 g of zinc and 1 g of sulfur are heated together, practically no zinc or sulfur remains after the compound zinc sulfide is formed. What happens if 2 g of zinc are heated with 2 g of sulfur?

M

		p-value 10	p-value 12
A. Zinc sulfide containing approximately twice as much sulfur is formed.	☐	12	13
B. Approximately 1 g of sulfur will be left over.	☒	29	33
C. Approximately 1 g of zinc will be left over.	☐	6	5
D. Approximately 1 g of each will be left over.	☐	10	5
E. No reaction will occur.	☐	9	8
F. I don't know.	☐	35	37

3.2.11 Y/30 What is the main problem associated with the disposal of waste products from a nuclear reactor? Some of the products

S

		p-value 10	p-value 12
A. remain radioactive for thousands of years.	☒	49	64
B. are likely to explode at any time.	☐	3	2
C. can destroy the ozone layer.	☐	14	11
D. give off dangerous levels of microwaves.	☐	17	12
E. I don't know.	☐	15	11

3.2.12 Y/32 A piece of granite has crystals about 5 mm in diameter. It was probably formed

M

		p-value 10	p-value 12
A. in a cave.	☐	10	8
B. from molten rock which cooled slowly.	☒	34	36
C. from swiftly flowing lava.	☐	10	8
D. in the sediment of a glacier.	☐	19	16
E. I don't know.	☐	27	31

TQ-ELEM

APPENDIX H

TEACHER QUESTIONNAIRE (ELEMENTARY)

School Code

SECOND ASSESSMENT OF SCIENCE 1982

A QUESTIONNAIRE FOR TEACHERS OF ELEMENTARY SCIENCE

Thank you for participating in this survey of science education in British Columbia. Your responses will influence decisions that will be made in curriculum, program implementation, teacher training, in-service, resource selection and budget allocation. If you wish to make detailed comments on any question or to express any concerns about science education, please use the last page. Your completion of this questionnaire will be a valued contribution to the future of teaching Science in elementary schools.

The September Assessment Update is enclosed for your information. It outlines the process being followed during the Science Assessment.

The results of this assessment will be available in your school in the Fall of 1982. If you wish to receive a personal copy of the report, be sure to complete and return the enclosed postcard.

Province of British Columbia
Ministry of Education
Learning Assessment Branch

A. TEACHER BACKGROUND AND GENERAL INFORMATION

1. How many years will you have been teaching as of June, 1982?

1 - 2 years	8^{1}
3 - 5 years	16^{2}
6 - 10 years	26^{3}
11 - 15 years	19^{4}
More than 15 years	30^{5}

2. Are you male or female?

Male	38^{1}
Female	62^{2}

3. How old are you?

24 years or under	4^{1}
25 - 29 years	18^{2}
30 - 34 years	22^{3}
35 - 39 years	20^{4}
40 - 49 years	22^{5}
50 years and over	13^{6}

4. In column 1, check ALL levels at which you have taught science NOW OR IN THE PAST. Then, in column 2, check ONLY those levels at which you are teaching science THIS YEAR. (*Check all that apply*)

	1. Have Taught Now or in Past	2. Am Teaching This Year
1. Elementary science, kindergarten/primary	59^{1}	45^{1}
2. Elementary science, intermediate	67^{1}	57^{1}
3. Secondary science	8^{1}	0^{1}
4. Other (specify): ____________________	2^{1}	0^{1}

5. How many university/college courses have you successfully completed in each of the following areas?
(One course = 3 units = 6 semester hours = 9 quarter hours)

	Number of Courses				
	None	Less Than One	One	Two or Three	Four or More
1. The teaching of science .	14^1	9^2	54^3	20^4	2^5
2. Biological sciences . . .	28^1	4^2	41^3	18^4	10^5
3. Earth/Space/ General Science	29^1	4^2	44^3	17^4	6^5
4. Physical sciences.	37^1	4^2	33^3	18^4	8^5
5. Other science or engineering courses . . .	68^1	2^2	13^3	10^4	7^5

6. How many years ago did you successfully complete a post-secondary course in methods of teaching science?

I have never successfully completed a post-secondary course in methods of teaching science.	18^1
Less than 2 years ago	5^2
2 - 5 years ago	16^3
6 - 10 years ago	25^4
11 or more years ago	35^5

7. How many students are enrolled in your school this year?

Fewer than 250	28^1
250 - 500	62^2
501 - 750	10^3
751 - 1000	0^4
Over 1000	0^5

B. COORDINATION

8. Think about the elementary science program in your SCHOOL. Which ONE of the following best describes the form of coordination which exists in your school?

There is a specially designated science coordinator or department head who is responsible for just the elementary grades.	3 ^{01}
There is a specially designated science coordinator or department head who is responsible for elementary and secondary grades.	0 ^{02}
There is a specially designated coordinator or department head who is responsible for science and one or more other subjects.	3 ^{03}
Coordination is performed by a working group of teachers in the school.	11 ^{04}
Coordination has been assumed by the principal or vice-principal.	7 ^{05}
Coordination has been assumed by one of the regular classroom teachers.	16 ^{06}
There is no particular form of coordination.	57 ^{07}
Other (specify): ________________________________	2 ^{08}

9. In general terms, how would you rate the form of coordination you checked in Question 8 for your school's elementary science program?

Excellent	3 ^{1}
Very good	9 ^{2}
Satisfactory	53 ^{3}
Unsatisfactory	30 ^{4}
Very unsatisfactory	5 ^{5}

10. Now, think about your DISTRICT's elementary science program. Which ONE of the following best describes the form of coordination which exists at the district level?

There is a specially designated science coordinator, supervisor or consultant responsible for just the elementary grades.	18^{1}
There is a specially designated science coordinator, supervisor or consultant who is responsible for elementary and secondary grades.	9^{2}
There is a specially designated coordinator, supervisor or consultant who is responsible for science and one or more other subjects.	16^{3}
Coordination is performed by a working group of teachers in the district.	17^{4}
Coordination has been assumed informally by one of the administrators or teachers in the district.	6^{5}
There is no particular form of coordination.	33^{6}
Other (specify): ______________________________	2^{7}

11. In general terms, how would you rate the form of coordination you checked in Question 10 for your district's elementary science program?

Excellent	4^{1}
Very good	14^{2}
Satisfactory	48^{3}
Unsatisfactory	28^{4}
Very unsatisfactory	8^{5}

C. PHYSICAL FACILITIES, MATERIALS AND EQUIPMENT

12. How adequate is each of the following in your school for the purposes of teaching science?

	Facility is:				
	Not Required	Needed But Not Available	Very Inadequate	Somewhat Inadequate	Adequate or Better
1. Lighting	11 ^{0}	1 ^{1}	4 ^{2}	13 ^{3}	71 ^{4}
2. Storage space for science materials/ equipment	1 ^{0}	4 ^{1}	25 ^{2}	36 ^{3}	35 ^{4}
3. Storage space for dangerous materials	33 ^{0}	4 ^{1}	19 ^{2}	18 ^{3}	27 ^{4}
4. Storage space for student projects.	5 ^{0}	13 ^{1}	38 ^{2}	33 ^{3}	12 ^{4}
5. Science preparation room	26 ^{0}	30 ^{1}	23 ^{2}	12 ^{3}	9 ^{4}
6. Water outlets . .	3 ^{0}	8 ^{1}	20 ^{2}	26 ^{3}	44 ^{4}
7. Electrical outlets	2 ^{0}	2 ^{1}	23 ^{2}	33 ^{3}	40 ^{4}
8. Sinks or drainage facilities . . .	1 ^{0}	7 ^{1}	17 ^{2}	30 ^{3}	45 ^{4}
9. Flat-topped desks or tables	2 ^{0}	6 ^{1}	12 ^{2}	25 ^{3}	54 ^{4}
10. Safety equipment .	26 ^{0}	6 ^{1}	14 ^{2}	23 ^{3}	32 ^{4}
11. Amount of work space per student	1 ^{0}	4 ^{1}	15 ^{2}	39 ^{3}	40 ^{4}
12. Audio-visual equipment	1 ^{0}	0 ^{1}	3 ^{2}	18 ^{3}	78 ^{4}
13. Ventilation . . .	4 ^{0}	2 ^{1}	12 ^{2}	25 ^{3}	58 ^{4}
14. Chalkboard space .	1 ^{0}	0 ^{1}	2 ^{2}	9 ^{3}	88 ^{4}
15. Bulletin board space	0 ^{0}	1 ^{1}	6 ^{2}	21 ^{3}	72 ^{4}
16. Microcomputers . .	56 ^{0}	18 ^{1}	14 ^{2}	5 ^{3}	7 ^{4}

13. How systematically is the safety equipment in your science area/ room/laboratory checked?

There is no safety equipment.	61^{1}
Casually; no systematic check	19^{2}
Systematically; once a year	15^{3}
Systematically; more than once a year	5^{4}

14. Apart from minor changes, how often in the past year have you had to adapt your teaching plans because of difficulty in obtaining the necessary science materials/equipment?

Never	16^{1}
Seldom, about once or twice	41^{2}
Fairly often, about three or four times	19^{3}
Quite often, about five or six times	10^{4}
Far too often, more than six times	8^{5}
I seldom plan to use equipment.	7^{6}

15. Overall, how do you rate the QUALITY of the science materials/ equipment available to you?

Excellent	5^{1}
Very good	18^{2}
Satisfactory	49^{3}
Unsatisfactory	25^{4}
Very unsatisfactory.	4^{5}

16. How much input do you have in deciding what science materials/ equipment are to be purchased in your school?

Virtually none	14^{1}
Some, but not enough	18^{2}
Some, about right	65^{3}
Too much, I do it all	3^{4}

17. Who maintains and accounts for the science materials/equipment in your school?

Each teacher of science looks after his/her own.	20 ^{1}
Each teacher of science looks after certain materials/equipment.	4 ^{2}
A specially designated teacher looks after it all.	46 ^{3}
Paid assistants look after it all.	2 ^{4}
There is no policy on who is responsible	20 ^{5}
Other (specify): ______________________________	8 ^{6}

18. What is the most frequent way for you to get your science materials/equipment?

Through a central source in the DISTRICT	32 ^{1}
Through a central source in the SCHOOL	44 ^{2}
Through a sharing arrangement between schools	1 ^{3}
I get my own.	21 ^{4}
Other (specify): ______________________________	2 ^{5}

19. How difficult is it to obtain science materials/equipment when you need it?

Not difficult at all	22 ^{1}
Not very difficult	39 ^{2}
Somewhat difficult	34 ^{3}
Very difficult	5 ^{4}

20. Where are most of the science materials/equipment stored in your school? (*Check one only*)

Convenient central storage room	41 ^{1}
Inconvenient central storage room	28 ^{2}
Distributed throughout the school	18 ^{3}
Designated classrooms	9 ^{4}
Other (specify): ______________________________	1 ^{5}

21. In your opinion, how adequate are the science reading materials in your school?

Very inadequate	11^{1}
Somewhat inadequate	31^{2}
Satisfactory	52^{3}
More than adequate	7^{4}

22. How often do you use the following audio visual aids when teaching science?

	Not Available	Never	Occasionally (1 - 5 Times/Unit)	Frequently (More than 5 Times/Unit)
1. Overhead	1^{0}	34^{1}	56^{2}	9^{3}
2. Large charts	5^{0}	10^{1}	70^{2}	16^{3}
3. Models	7^{0}	15^{1}	72^{2}	6^{3}
4. Films	1^{0}	4^{1}	69^{2}	25^{3}
5. Filmstrips	0^{0}	5^{1}	70^{2}	25^{3}
6. 35 mm slides	12^{0}	56^{1}	31^{2}	2^{3}
7. Audio tapes.	8^{0}	49^{1}	36^{2}	6^{3}
8. Video tapes.	8^{0}	34^{1}	51^{2}	8^{3}
9. Microcomputers	51^{0}	45^{1}	3^{2}	1^{3}
10. Other (specify): ____________________	7^{0}	27^{1}	37^{2}	29^{3}

D. SCIENCE TEACHING

23. In your opinion, how worthwhile is the prescribed B.C. science program to the students you are presently teaching?

Very worthwhile	24^{1}
Of some worth	64^{2}
Of little worth	9^{3}
Practically worthless	3^{4}

24. If you had a choice, at which ONE of the following grade levels, if any, would you prefer to teach science?

I would prefer not to teach science at all.	11^{1}
Primary/kindergarten	36^{2}
Intermediate	49^{3}
Junior secondary	1^{4}
Senior secondary	1^{5}
Junior-senior secondary	1^{6}
Post-secondary	0^{7}

25. In general, how well prepared do you feel for the teaching of science?

Not at all	5^{1}
Somewhat	37^{2}
Adequately	46^{3}
More than adequately	12^{4}

26. During this school year, how much time during each week, on the average, do you actually teach science?

1 - 30 minutes	10^{1}
31 - 60 minutes	30^{2}
61 - 90 minutes	26^{3}
91 - 180 minutes	22^{4}
181 - 300 minutes	6^{5}
Over 300 minutes	6^{6}

27. To how many different classes do you teach science?

My own class only	78^{1}
Two or three different classes	19^{2}
Four or more different classes	4^{3}

28. Compared to the present, would you like to see more, the same or less of each of the following in your school's SCIENCE PROGRAM at the elementary level?

	Less	Same	More
1. Provision of print materials other than textbooks	2^{1}	24^{2}	75^{3}
2. Integration of science with other subject areas	1^{1}	47^{2}	51^{3}
3. Discovery learning	4^{1}	44^{2}	52^{3}
4. Activity-centred learning	2^{1}	42^{2}	56^{3}
5. Alternate programs in science	3^{1}	47^{2}	50^{3}
6. Locally developed programs	3^{1}	42^{2}	55^{3}
7. Outdoor education	2^{1}	50^{2}	48^{3}
8. Teaching of basic science concepts	1^{1}	63^{2}	37^{3}
9. Teaching of science processes (e.g., classifying, controlling variables, measuring)	2^{1}	62^{2}	36^{3}
10. Definition of core curriculum	9^{1}	60^{2}	31^{3}
11. Background information for teachers	1^{1}	28^{2}	71^{3}
12. Provincial learning assessment	23^{1}	66^{2}	11^{3}
13. District learning assessment	17^{1}	65^{2}	18^{3}
14. Freedom for teacher to define course	7^{1}	62^{2}	31^{3}
15. Teacher input into purchase of equipment	0^{1}	63^{2}	37^{3}
16. Environmental education	2^{1}	46^{2}	52^{3}
17. Field trips	1^{1}	49^{2}	50^{3}
18. Provisions for meeting the needs of gifted children	1^{1}	32^{2}	67^{3}
19. Provisions for meeting the needs of handicapped children	2^{1}	52^{2}	46^{3}
20. Specialist science teachers in elementary schools	6^{1}	39^{2}	56^{3}
21. Emphasis on the impact of science on society	2^{1}	52^{2}	46^{3}

E. TEACHER EDUCATION

29. How much emphasis do you feel SHOULD be placed on each of the following in preparing student teachers to teach science?

	Very Little Emphasis	Some Emphasis	Moderate Emphasis	Heavy Emphasis
1. Techniques of teaching science .	0	9	45	46
2. Techniques for developing reading skills in science . . .	4	29	49	18
3. Techniques for developing writing skills in science . . .	5	33	49	18
4. Subject matter in specific areas of science	2	20	52	27
5. General science	1	16	52	31
6. History & philosophy of science.	37	47	15	2
7. Psychology of learning	19	39	28	15
8. Testing/evaluating/grading in science	7	32	47	14
9. Child psychology	19	40	28	13
10. Theories of intellectual development	26	42	24	8
11. Survey of available curriculum materials	4	26	42	28
12. How to develop curriculum materials	2	17	36	45
13. Lesson planning	1	12	39	48
14. Preparation of science materials	1	14	43	43
15. Practice in teaching science . .	0	7	35	59
16. Discussion of problems of science teaching	3	24	45	28
17. Care and observation of animals in the classroom . . .	11	43	35	10
18. Care & maintenance of equipment.	5	43	39	14
19. Laboratory safety	2	28	35	36
20. Special education	15	47	31	7
21. Integration with other subjects.	4	30	38	28
22. Use of community resources . . .	1	23	45	31
23. Use of audio-visual materials .	2	24	51	24
24. Other (specify): ____________	11	5	21	64

30. How much emphasis WAS placed on each of the following in your pre-service preparation period for the teaching of science?

	Very Little Emphasis	Some Emphasis	Moderate Emphasis	Heavy Emphasis
1. Techniques of teaching science .	23^{1}	39^{2}	29^{3}	9^{4}
2. Techniques for developing reading skills in science . . .	61^{1}	24^{2}	8^{3}	1^{4}
3. Techniques for developing writing skills in science . . .	68^{1}	23^{2}	7^{3}	2^{4}
4. Subject matter in specific areas of science	28^{1}	34^{2}	29^{3}	10^{4}
5. General science	20^{1}	33^{2}	39^{3}	8^{4}
6. History & philosophy of science.	71^{1}	21^{2}	7^{3}	1^{4}
7. Psychology of learning	42^{1}	30^{2}	21^{3}	7^{4}
8. Testing/evaluating/grading in science	43^{1}	35^{2}	19^{3}	4^{4}
9. Child psychology	45^{1}	29^{2}	20^{3}	7^{4}
10. Theories of intellectual development	51^{1}	29^{2}	15^{3}	5^{4}
11. Survey of available curriculum materials	41^{1}	33^{2}	20^{3}	5^{4}
12. How to develop curriculum materials	36^{1}	34^{2}	22^{3}	8^{4}
13. Lesson planning	12^{1}	27^{2}	38^{3}	24^{4}
14. Preparation of science materials	27^{1}	37^{2}	29^{3}	7^{4}
15. Practice in teaching science . .	25^{1}	35^{2}	31^{3}	9^{4}
16. Discussion of problems of science teaching	52^{1}	32^{2}	14^{3}	3^{4}
17. Care and observation of animals in the classroom . . .	76^{1}	17^{2}	6^{3}	1^{4}
18. Care & maintenance of equipment.	62^{1}	27^{2}	9^{3}	2^{4}
19. Laboratory safety	61^{1}	25^{2}	10^{3}	4^{4}
20. Special education	82^{1}	13^{2}	4^{3}	1^{4}
21. Integration with other subjects.	44^{1}	33^{2}	17^{3}	5^{4}
22. Use of community resources . . .	52^{1}	31^{2}	13^{3}	3^{4}
23. Use of audio-visual materials .	36^{1}	36^{2}	22^{3}	5^{4}
24. Other (specify): ____________ ______________________________	39^{1}	9^{2}	22^{3}	30^{4}

31. How adequately did your pre-service teacher education program prepare you for teaching elementary science?

Very inadequately	26^{1}
Somewhat inadequately	44^{2}
Adequately	28^{3}
More than adequately	2^{4}

32. How much in-service education do you feel you require THIS YEAR to do a good job teaching science?

None	20^{1}
3 - 5 hours (one afternoon workshop)	32^{2}
Several sessions of 3 - 5 hours	37^{3}
An intensive refresher course	11^{4}

33. Based on your previous experience, indicate the value of each of the following to your teaching.

	Have Not Experienced	Have Experienced		
		Little Value	Moderate Value	Much Value
1. Informal meetings with other science teachers	28^{0}	9^{1}	37^{2}	25^{3}
2. Informal meetings with university science education instructors . .	61^{0}	17^{1}	18^{2}	5^{3}
3. Informal meetings with scientists.	78^{0}	9^{1}	9^{2}	4^{3}
4. Workshops presented by other teachers	16^{0}	6^{1}	45^{2}	32^{3}
5. Workshops presented by university science educators	45^{0}	14^{1}	30^{2}	11^{3}
6. Workshops presented by a district resource person	30^{0}	7^{1}	38^{2}	26^{3}
7. Workshops presented by scientists.	79^{0}	8^{1}	9^{2}	4^{3}
8. Workshops presented by Ministry of Education officials	85^{0}	8^{1}	6^{2}	20^{3}
9. University credit courses in science content	29^{0}	18^{1}	37^{2}	16^{3}
10. University credit courses in science methods	30^{0}	20^{1}	37^{2}	12^{3}
11. Visits to other classrooms	32^{0}	8^{1}	35^{2}	25^{3}
12. Annual conferences for science teachers.	71^{0}	5^{1}	14^{2}	10^{3}
13. Other (specify): ______________ ______________________________	27^{0}	0^{1}	10^{2}	63^{3}

34. How effective are the science in-service education activities which are provided in your school/district?

No in-service activities specifically provided for science	33^{0}
Very ineffective	6^{1}
Somewhat ineffective	19^{2}
Fairly effective	36^{3}
Very effective	6^{4}

35. Generally, how willing would you be to participate in a science in-service education workshop after school hours (*first column*) or on weekends (*second column*)?

	1. After School Hours	2. On Weekends
Definitely would not participate	4^{1}	32^{1}
Probably would not participate	14^{2}	32^{2}
Probably would participate	59^{3}	28^{3}
Definitely would participate	23^{4}	8^{4}

36. Generally, how willing would you be to participate in an in-service education workshop in science during school hours IF RELEASE TIME WERE GIVEN?

Definitely would not participate	1^{1}
Probably would not participate	5^{2}
Probably would participate	33^{3}
Definitely would participate	61^{4}

F. ASSESSMENT AND TESTING

37. Have you read the following publications concerning the B.C. Science Assessment (1978)?

	Yes	No
1. Your District's Interpretation Report	15^1	85^2
2. Provincial Summary Report	19^1	81^2
3. Provincial General Report, Volume 1 (*student surveys*).	5^1	95^2
4. Provincial General Report, Volume 2 (*teacher surveys*).	5^1	94^2

38. In your school, what impact have the results and recommendations from the previous B.C. Science Assessment had on each of the following?

	None	Minimal	Significant	I don't know
1. Allocation of personnel	35^1	11^2	2^3	52^4
2. Provision of in-service	26^1	20^2	6^3	48^4
3. Change in curriculum emphasis	19^1	9^2	16^3	46^4
4. Change in evaluation practices	24^1	20^2	4^3	52^4
5. Provision of supplementary materials . .	20^1	20^2	12^3	48^4
6. Provision for special needs students . . .	31^1	14^2	2^3	53^4
7. Improvement of instructional practices . .	22^1	18^2	6^3	54^4
8. Increase in time scheduled for science instruction .	29^1	18^2	8^3	45^4
9. Your own teaching . .	33^1	28^2	9^3	30^4

G. GRADE-SPECIFIC INFORMATION

The questions in the remainder of the questionnaire are meaningful only if answered with a specific grade in mind. This will be identified by answering questions 39 to 41.

39. Do you teach science to more than one grade at the elementary level?

No	73^{1}	*(go to Question 40)*
Yes	27^{2}	*(go to Question 41)*

40. Which ONE of the following best describes this grade?

Grade/Year 1	17^{1}
Grade/Year 2	15^{2}
Grade/Year 3	17^{3}
Grade/Year 4	13^{4}
Grade/Year 5	13^{5}
Grade/Year 6	12^{6}
Grade/Year 7	13^{7}

Now please skip to Question 42

41. (*If YES to Question 39*) Please identify the ONE grade with which you have had both RECENT and EXTENSIVE experience in the teaching of science. If this is not possible, choose the grade with which you have had the most RECENT experience. Note that all of the remaining questions refer to this specific grade. Which one of the following best describes the grade you have selected? (*If there is more than one grade level represented in your class, please select only ONE of those grades, preferably the one with the largest enrolment.*)

Grade/Year 1	11^{1}
Grade/Year 2	12^{2}
Grade/Year 3	13^{3}
Grade/Year 4	13^{4}
Grade/Year 5	14^{5}
Grade/Year 6	16^{6}
Grade/Year 7	21^{7}

42. How many students are in your largest science class at this grade level this year?

20 or fewer	15^{1}
21 - 24	30^{2}
25 - 28	33^{3}
29 - 32	18^{4}
Over 32	4^{5}

H. ELEMENTARY SCIENCE PROGRAM

43. For which of the following programs is the printed material available to you in your school?
(*Check all that apply*)

1. Materials-based program	44^{1}
2. STEM	86^{1}
3. Exploring Science	89^{1}
4. None of these	2^{1}
5. I don't know	1^{1}

44. Do you actually USE one program or a combination?

One program exclusively	5^{1}
One program supplemented by my own ideas	21^{2}
A combination of programs	14^{3}
A combination of programs supplemented by my own ideas	1^{5}
A locally developed program	59^{4}

45. Who actually chose the program to be used for this grade?
(*Check all that apply*)

1. District supervisory personnel	26^{1}
2. School principal	6^{1}
3. Advisory group of teachers and/or principals	25^{1}
4. Classroom teachers	44^{1}
5. Other (specify): ______________________	6^{1}
6. I don't know.	15^{1}

46. What was the MAIN factor behind the choice of program for this grade level?

The program was thought to promote the best approach to science teaching.	36^{1}
The program seemed most usable for classroom teachers not trained in science.	20^{2}
The program was least expensive.	0^{3}
The program was most readily available.	10^{4}
Other (specify): ______________________	5^{5}
I don't know.	29^{6}

47. What percentage of time do you actually USE each of the following for the teaching of science at this grade level?

	0%	1-5%	6-25%	26-50%	51-100%
1. STEM textbooks	19^{1}	18^{2}	32^{3}	23^{4}	8^{5}
2. Exploring Science textbooks .	13^{1}	12^{2}	26^{3}	26^{4}	23^{5}
3. Materials-based units	22^{1}	18^{2}	33^{3}	20^{4}	7^{5}
4. Materials-based Program Interim Guide	59^{1}	17^{2}	15^{3}	6^{4}	3^{5}
5. Elementary Science Interim Guide	46^{1}	26^{2}	17^{3}	6^{4}	5^{5}
6. Locally-developed units . . .	31^{1}	17^{2}	32^{3}	13^{4}	8^{5}
7. Teacher-developed units . . .	8^{1}	10^{2}	33^{3}	28^{4}	21^{5}
8. B.C.T.F. Lesson Aids	40^{1}	31^{2}	23^{3}	5^{4}	1^{5}
9. Other (specify):	60^{1}	7^{2}	15^{3}	10^{4}	8^{5}

48. With which ONE of the following programs are you MOST familiar?

Materials-based program	14^{1}	
STEM	33^{2}	
Exploring Science	48^{3}	
None of these	6^{4}	*(Go to Question 52)*

49. Please rate the program you identified in question 48 on each of the following attributes.

	Poor	Less Than Satis- factory	Satis- factory	More Than Satis- factory	Excellent
1. Availability of materials	7^{1}	18^{2}	57^{3}	14^{4}	4^{5}
2. Readability of text(s) .	3^{1}	11^{2}	63^{3}	18^{4}	5^{5}
3. Relevance to students .	1^{1}	9^{2}	65^{3}	21^{4}	4^{5}
4. Ease of teaching	2^{1}	11^{2}	60^{3}	24^{4}	4^{5}
5. Ease of preparation . .	2^{1}	14^{2}	62^{3}	20^{4}	3^{5}
6. Usefulness of teacher's guide	3^{1}	10^{2}	57^{3}	23^{4}	7^{5}
7. Balance between content and process . .	2^{1}	16^{2}	65^{3}	15^{4}	3^{5}
8. Amount of student activity	3^{1}	22^{2}	52^{3}	16^{4}	6^{5}
9. Degree of structure . .	1^{1}	7^{2}	73^{3}	17^{4}	2^{5}
10. Suitability to teacher's background	1^{1}	6^{2}	65^{3}	23^{4}	6^{5}
11. Selection of content . .	1^{1}	8^{2}	67^{3}	20^{4}	3^{5}
12. Interest of students . .	1^{1}	11^{2}	58^{3}	24^{4}	6^{5}
13. Overall rating	2^{1}	10^{2}	63^{3}	23^{4}	3^{5}

50. If you could use only ONE program, which of the three would you prefer for this grade level? (*Check one only*)

STEM	30^{1}
Exploring Science	43^{2}
Materials-based program	27^{3}

MATERIALS BASED

49. Please rate the program you identified in question 48 on each of the following attributes.

	Poor	Less Than Satis- factory	Satis- factory	More Than Satis- factory	Excellent
1. Availability of materials	5 ^{1}	19 ^{2}	43 ^{3}	24 ^{4}	9 ^{5}
2. Readability of text(s) .	10 ^{1}	18 ^{2}	56 ^{3}	14 ^{4}	2 ^{5}
3. Relevance to students .	3 ^{1}	3 ^{2}	43 ^{3}	38 ^{4}	14 ^{5}
4. Ease of teaching	4 ^{1}	11 ^{2}	47 ^{3}	31 ^{4}	7 ^{5}
5. Ease of preparation . .	6 ^{1}	22 ^{2}	49 ^{3}	19 ^{4}	4 ^{5}
6. Usefulness of teacher's guide	4 ^{1}	7 ^{2}	57 ^{3}	26 ^{4}	7 ^{5}
7. Balance between content and process . .	4 ^{1}	10 ^{2}	58 ^{3}	20 ^{4}	8 ^{5}
8. Amount of student activity	0 ^{1}	2 ^{2}	34 ^{3}	35 ^{4}	29 ^{5}
9. Degree of structure . .	1 ^{1}	9 ^{2}	66 ^{3}	21 ^{4}	4 ^{5}
10. Suitability to teacher's background	1 ^{1}	7 ^{2}	51 ^{3}	27 ^{4}	15 ^{5}
11. Selection of content . .	1 ^{1}	6 ^{2}	62 ^{3}	26 ^{4}	6 ^{5}
12. Interest of students . .	0 ^{1}	3 ^{2}	35 ^{3}	42 ^{4}	21 ^{5}
13. Overall rating	1 ^{1}	6 ^{2}	46 ^{3}	38 ^{4}	9 ^{5}

EXPLORING SCIENCE

49. Please rate the program you identified in question 48 on each of the following attributes.

	Poor	Less Than Satis-factory	Satis-factory	More Than Satis-factory	Excellent
1. Availability of materials	7^{1}	17^{2}	58^{3}	15^{4}	3^{5}
2. Readability of text(s) .	1^{1}	10^{2}	61^{3}	21^{4}	7^{5}
3. Relevance to students .	0^{1}	9^{2}	66^{3}	22^{4}	3^{5}
4. Ease of teaching	1^{1}	10^{2}	57^{3}	28^{4}	5^{5}
5. Ease of preparation . .	1^{1}	11^{2}	60^{3}	24^{4}	4^{5}
6. Usefulness of teacher's guide	4^{1}	12^{2}	55^{3}	22^{4}	7^{5}
7. Balance between content and process . .	2^{1}	20^{2}	63^{3}	14^{4}	1^{5}
8. Amount of student activity	5^{1}	29^{2}	53^{3}	10^{4}	2^{5}
9. Degree of structure . .	1^{1}	7^{2}	73^{3}	17^{4}	3^{5}
10. Suitability to teacher's background	0^{1}	6^{2}	64^{3}	26^{4}	5^{5}
11. Selection of content . .	1^{1}	8^{2}	66^{3}	22^{4}	4^{5}
12. Interest of students . .	1^{1}	12^{2}	61^{3}	22^{4}	4^{5}
13. Overall rating	1^{1}	10^{2}	64^{3}	23^{4}	3^{5}

STEM

49. Please rate the program you identified in question 48 on each of the following attributes.

	Poor	Less Than Satisfactory	Satisfactory	More Than Satisfactory	Excellent
1. Availability of materials	7^{1}	20^{2}	61^{3}	11^{4}	2^{5}
2. Readability of text(s) .	3^{1}	11^{2}	66^{3}	17^{4}	3^{5}
3. Relevance to students .	1^{1}	11^{2}	70^{3}	16^{4}	2^{5}
4. Ease of teaching	2^{1}	11^{2}	67^{3}	19^{4}	2^{5}
5. Ease of preparation . .	1^{1}	15^{2}	68^{3}	15^{4}	2^{5}
6. Usefulness of teacher's guide	1^{1}	8^{2}	58^{3}	25^{4}	8^{5}
7. Balance between content and process . .	1^{1}	14^{2}	68^{3}	15^{4}	3^{5}
8. Amount of student activity	1^{1}	23^{2}	55^{3}	18^{4}	3^{5}
9. Degree of structure . .	1^{1}	8^{2}	74^{3}	16^{4}	1^{5}
10. Suitability to teacher's background	1^{1}	6^{2}	72^{3}	18^{4}	3^{5}
11. Selection of content . .	2^{1}	11^{2}	69^{3}	17^{4}	2^{5}
12. Interest of students . .	1^{1}	14^{2}	60^{3}	22^{4}	3^{5}
13. Overall rating	2^{1}	11^{2}	67^{3}	19^{4}	2^{5}

51. Check ALL the reasons for your choice in question 50. (*Check all that apply*)

1. Materials readily available	56^{1}
2. More readable	47^{1}
3. More relevant to students	61^{1}
4. Easier to teach	59^{1}
5. Easier to prepare	53^{1}
6. Better teacher's guide	37^{1}
7. Better balance between content and process	46^{1}
8. Right amount of activity	55^{1}
9. Right degree of structure	43^{1}
10. Suited to my background	58^{1}
11. Other (specify): ________________________________	5^{1}

52. How do you or will you supplement the elementary science program selected for your grade level? (*Check all that apply*)

1. No need to supplement	3^{1}
2. No time to supplement	9^{1}
3. Additional reading for students	32^{1}
4. Additional content for students	46^{1}
5. Additional activities for students	81^{1}
6. Additional equipment for student use	38^{1}
7. Integration with other subjects	61^{1}

53. Are sufficient materials available for teaching the selected program at your grade level?

There are sufficient materials.	57^{1}
There are insufficient materials.	39^{2}
No materials are available.	1^{3}
I don't know.	2^{4}

I. INSTRUCTIONAL PRACTICES

54. Indicate for each of the following whether, DURING THIS SCHOOL YEAR, you kept or will keep the item in your classroom occasionally, throughout the year, or not at all.

		Yes	
	No	Occasionally	Always
1. Aquarium	65^{1}	24^{2}	12^{3}
2. Terrarium	63^{1}	33^{2}	5^{3}
3. Animals	53^{1}	34^{2}	13^{3}
4. Thermometers	12^{1}	58^{2}	30^{3}
5. Globe	8^{1}	39^{2}	54^{3}
6. Batteries	37^{1}	55^{2}	8^{3}
7. Equal arm or pegboard balances	43^{1}	44^{2}	14^{3}
8. Spring scales	37^{1}	54^{2}	9^{3}
9. Hand lens	17^{1}	61^{2}	22^{3}
10. Magnets	19^{1}	66^{2}	14^{3}
11. Magnetic compasses	36^{1}	56^{2}	9^{3}
12. Plasticene	22^{1}	37^{2}	42^{3}
13. Flashlights	36^{1}	59^{2}	5^{3}
14. Mirrors	27^{1}	60^{2}	13^{3}
15. Balloons	25^{1}	61^{2}	14^{3}
16. Potted plants	14^{1}	46^{2}	40^{3}
17. Seeds	16^{1}	72^{2}	11^{3}
18. Candles	32^{1}	57^{2}	10^{3}
19. Rocks and minerals	25^{1}	63^{2}	12^{3}
20. Barometer	67^{1}	26^{2}	7^{3}
21. Alcohol burners	76^{1}	21^{2}	3^{3}
22. Hot plate	53^{1}	41^{2}	6^{3}
23. Clock with second hand	16^{1}	18^{2}	65^{3}

55. How often do you engage your students at this grade level in each of the following for the teaching of science?

	Never	Rarely - (Once or Twice During Year)	Occa-sionally	About Half the Time	Fre-quently	Very Frequently (Almost Every Class Period)
1. Carrying out experiments from a set of instructions .	6^{1}	15^{2}	55^{3}	11^{4}	11^{5}	2^{6}
2. Making up their own experiments .	22^{1}	34^{2}	38^{3}	3^{4}	3^{5}	0^{6}
3. Discussing the possible errors in an experiment that has been completed	9^{1}	18^{2}	46^{3}	7^{4}	19^{5}	2^{6}
4. Listening to teacher's explanations . . .	1^{1}	2^{2}	38^{3}	29^{4}	24^{5}	6^{6}
5. Interacting with the teacher in a mix of questions and explanations .	0^{1}	1^{2}	19^{3}	30^{4}	36^{5}	14^{6}
6. Making a graph from the data students get from an experiment . .	6^{1}	19^{2}	50^{3}	8^{4}	16^{5}	1^{6}
7. Generalizing information to new problem situations . .	3^{1}	13^{2}	49^{3}	13^{4}	19^{5}	2^{6}
8. Making guesses about the results of an experiment .	2^{1}	7^{2}	40^{3}	13^{4}	33^{5}	5^{6}
9. Interpreting or explaining for themselves the results of an experiment	2^{1}	9^{2}	39^{3}	15^{4}	30^{5}	4^{6}
10. Classifying objects or events .	1^{1}	7^{2}	44^{3}	13^{4}	31^{5}	4^{6}
11. Describing/reporting observations in their own words .	1^{1}	5^{2}	36^{3}	15^{4}	35^{5}	8^{6}
12. Measuring in an experiment	3^{1}	10^{2}	51^{3}	13^{4}	21^{5}	3^{6}

57. What provisions are made in your CLASS for individual differences among students in science? (*Check all that apply*)

1. No special provisions	51^{1}
2. Individualized instruction	22^{1}
3. Achievement grouping within the class	19^{1}
4. Special interest groups	28^{1}
5. Other (specify): ____________	7^{1}

58. How much emphasis do you place on each of the following in deriving a final evaluation for your students in SCIENCE at this grade level?

	No Emphasis	Little Emphasis	Some Emphasis	Much Emphasis
1. Anecdotal records of achievement	11^{1}	19^{2}	51^{3}	19^{4}
2. Anecdotal records of general attitude in class	7^{1}	16^{2}	57^{3}	20^{4}
3. Anecdotal records of work habits	5^{1}	15^{2}	59^{3}	21^{4}
4. Teacher-made objective tests	15^{1}	14^{2}	42^{3}	29^{4}
5. Standardized objective tests	55^{1}	24^{2}	16^{3}	5^{4}
6. Subjective tests (essay, paragraph, etc.)	36^{1}	28^{2}	32^{3}	5^{4}
7. Activity/experiment write-ups	17^{1}	22^{2}	46^{3}	15^{4}
8. Individual work contracts	57^{1}	24^{2}	15^{3}	4^{4}
9. Reports on topics in science	16^{1}	23^{2}	52^{3}	10^{4}
10. Projects	11^{1}	17^{2}	57^{3}	15^{4}
11. Oral tests	35^{1}	29^{2}	30^{3}	6^{4}
12. Student self reports	52^{1}	24^{2}	22^{3}	3^{4}
13. Attendance	61^{1}	17^{2}	15^{3}	6^{4}
14. Other (specify): ____________	40^{1}	3^{2}	25^{3}	31^{4}

55. (Continued)

	Never	Rarely - (Once or Twice During Year)	Occasionally	About Half the Time	Frequently	Very Frequently (Almost Every Class Period)
13. Answering questions from worksheets or textbooks . . .	10^{1}	15^{2}	46^{3}	14^{4}	13^{5}	2^{6}
14. Discussing experiment results with other students	5^{1}	14^{2}	47^{3}	12^{4}	20^{5}	3^{6}
15. Copying notes from blackboard/overhead projector	19^{1}	18^{2}	44^{3}	9^{4}	9^{5}	1^{6}
16. Watching audio-visual materials .	1^{1}	5^{2}	57^{3}	11^{4}	25^{5}	1^{6}
17. Memorizing scientific information . . .	27^{1}	27^{2}	38^{3}	4^{4}	5^{5}	0^{6}
18. Doing investigations at home . .	9^{1}	31^{2}	51^{3}	3^{4}	5^{5}	0^{6}
19. Reading from textbooks	15^{1}	13^{2}	42^{3}	14^{4}	13^{5}	3^{6}
20. Doing library research	6^{1}	16^{2}	57^{3}	9^{4}	11^{5}	1^{6}
21. Going on field trips	3^{1}	31^{2}	57^{3}	3^{4}	6^{5}	0^{6}
22. Discussing science issues and values in society	15^{1}	28^{2}	44^{3}	4^{4}	8^{5}	1^{6}

56. What provisions are made in your SCHOOL for individual differences among students in science? (*Check all that apply*)

1. No special provisions	66^{1}
2. Continuous progress	14^{1}
3. Learning assistance classes	13^{1}
4. Modified and/or enriched programs	23^{1}
5. Other (specify): ______________________________	3^{1}

59. (Continued)

	The quality of learning would likely				
	Deteriorate Seriously	Deteriorate Somewhat	Remain the Same	Improve Somewhat	Improve Greatly
14. More university courses in science (taken by yourself) . .	0^{1}	1^{2}	28^{3}	60^{4}	12^{5}
15. Higher priority placed on science by administration	0^{1}	2^{2}	43^{3}	48^{4}	7^{5}
16. Less in-service education	9^{1}	43^{2}	47^{3}	2^{4}	0^{5}
17. More time allocated to science.	0^{1}	2^{2}	42^{3}	50^{4}	6^{5}
18. Changes in the new program . . .	0^{1}	3^{2}	54^{3}	38^{4}	5^{5}
19. Increased availability of equipment & materials.	0^{1}	0^{2}	20^{3}	56^{4}	24^{5}
20. Especially designed classroom for science	0^{1}	1^{2}	17^{3}	42^{4}	40^{5}
21. Fewer subjects/ levels to teach .	0^{1}	1^{2}	27^{3}	42^{4}	31^{5}
22. Increased emphasis on core curriculum .	0^{1}	14^{2}	65^{3}	16^{4}	3^{5}
23. More choice for teacher in selection of program .	1^{1}	2^{2}	49^{3}	36^{4}	12^{5}

59. How would each of the following changes be likely to affect the quality of science learning in YOUR classroom?

	The quality of learning would likely				
	Deteriorate Seriously	Deteriorate Somewhat	Remain the Same	Improve Somewhat	Improve Greatly
1. More direct input by you into the purchase of equipment	0^{1}	0^{2}	51^{3}	42^{4}	7^{5}
2. Better quality of equipment . .	0^{1}	0^{2}	38^{3}	50^{4}	12^{5}
3. Less responsibility for maintenance of equipment . .	2^{1}	7^{2}	77^{3}	11^{4}	4^{5}
4. Smaller class size . . .	0^{1}	0^{2}	28^{3}	39^{4}	33^{5}
5. Provision of wider selection of printed materials (texts)	0^{1}	2^{2}	38^{3}	45^{4}	15^{5}
6. More coordination at school level .	0^{1}	1^{2}	39^{3}	46^{4}	15^{5}
7. More coordination at district level .	0^{1}	2^{2}	46^{3}	39^{4}	14^{5}
8. Decreased emphasis on core curriculum . . .	2^{1}	11^{2}	66^{3}	18^{4}	4^{5}
9. Increased provision of in-service . .	0^{1}	0^{2}	17^{3}	58^{4}	26^{5}
10. More science books in library . . .	0^{1}	0^{2}	32^{3}	51^{4}	17^{5}
11. More time to prepare and mark.	0^{1}	0^{2}	16^{3}	39^{4}	46^{5}
12. Fewer classes to teach	0^{1}	1^{2}	49^{3}	28^{4}	23^{5}
13. More convenient storage space for equipment . .	0^{1}	0^{2}	40^{3}	37^{4}	23^{5}

60. Please use this space to make any other comments on the science program in your school.

TQ-SEC

APPENDIX I

TEACHER QUESTIONNAIRE (SECONDARY)

School Code

SECOND ASSESSMENT OF SCIENCE 1982

A QUESTIONNAIRE FOR SECONDARY TEACHERS OF SCIENCE

Thank you for participating in this survey of science education in British Columbia. Although this questionnaire may at first appear lengthy, the directions will ask you to omit about one third of the questions because you will be responding only to those that relate to your self-selected specialization within the range of courses from Science 8 to Physics 12.

Your responses will influence decisions that will be made in curriculum, program implementation, teacher training, in-service, resource selection and budget allocation. If you wish to make detailed comments on any question or to express any concerns about science education, please use the last page. Your completion of this questionnaire will be a valued contribution to the future of teaching Science in secondary schools.

The September Assessment Update is enclosed for your information. It outlines the process being followed during the Science Assessment.

The results of this assessment will be available in your school in the Fall of 1982. If you wish to receive a personal copy of the report, be sure to complete and return the enclosed postcard.

Province of British Columbia
Ministry of Education
Learning Assessment Branch

A. TEACHER BACKGROUND AND GENERAL INFORMATION

1. How many years will you have been teaching as of June, 1982?

1 - 2 years	6	1
3 - 5 years	13	2
6 - 10 years	23	3
11 - 15 years	25	4
More than 15 years	33	5

2. Are you male or female?

Male	89	1
Female	11	2

3. How old are you?

24 years or under	2	1
25 - 29 years	14	2
30 - 34 years	19	3
35 - 39 years	26	4
40 - 49 years	27	5
50 years and over	13	6

4. How many university/college courses have you successfully completed in each of the following areas? *(One course = 3 units = 6 semester hours = 9 quarter hours)*

	Number of Courses				
	None	Less Than One	One	Two or Three	Four or More
1. The teaching of science	8^{1}	3^{2}	31^{3}	39^{4}	19^{5}
2. Biological Sciences	10^{1}	3^{2}	20^{3}	11^{4}	56^{5}
3. Earth/Space/ General Science	16^{1}	5^{2}	39^{3}	24^{4}	17^{5}
4. Physical Sciences	3^{1}	1^{2}	16^{3}	29^{4}	51^{5}
5. Other science or engineering courses	17^{1}	1^{2}	10^{3}	32^{4}	41^{5}

5. How many years ago did you successfully complete a post-secondary course in methods of teaching science?

I have never successfully completed a post-secondary course in methods of teaching science	9^{1}
Less than 2 years ago	6^{2}
2 - 5 years ago	16^{3}
6 - 10 years ago	25^{4}
11 or more years ago	45^{5}

6. Which ONE of the following describes your position in the school? *(Check one only)*

Regular classroom teacher	74^{1}
Department head	20^{2}
Vice-principal	2^{3}
Principal	2^{4}
Counsellor/Librarian	1^{5}
Other (specify): ____________	1^{6}

7. In column 1, check ALL science courses you have taught NOW OR IN THE PAST. Then, in column 2, check ONLY those science courses which you are teaching THIS YEAR. (*Check all that apply*)

	1. Have Taught Now or in Past	2. Am Teaching This Year
1. Elementary science, kindergarten/primary	5[1]	0[1]
2. Elementary science, intermediate	20[1]	4[1]
3. Science 8	82[1]	49[1]
4. Science 9	83[1]	48[1]
5. Science 10	83[1]	53[1]
6. Biology 11	37[1]	19[1]
7. Biology 12	28[1]	15[1]
8. Chemistry 11	35[1]	17[1]
9. Chemistry 12	22[1]	14[1]
10. Physics 11	27[1]	15[1]
11. Physics 12	18[1]	10[1]
12. Earth Science 11	9[1]	5[1]
13. Geology 12	3[1]	1[1]
14. Special electives	8[1]	2[1]
15. Other (specify) ____________________	12[1]	6[1]

8. How many students are enrolled in your school this year?

Fewer than 250	7[1]
250 - 500	20[2]
501 - 750	29[3]
751 - 1000	19[4]
Over 1000	25[5]

B. COORDINATION

9. Think about the secondary science program in your SCHOOL. Which ONE of the following best describes the form of coordination which exists in your school?

There is a specially designated science coordinator or department head who is responsible for just the secondary grades.	72 ^{01}
There is a specially designated science coordinator or department head who is responsible for elementary and secondary grades.	1 ^{02}
There is a specially designated coordinator or department head who is responsible for science and one or more other subjects.	8 ^{03}
Coordination is performed by a working group of teachers in the school.	7 ^{04}
Coordination has been assumed by the principal or vice-principal.	1 ^{05}
Coordination has been assumed by one of the regular classroom teachers.	5 ^{06}
There is no particular form of coordination.	4 ^{07}
Other (specify): ______________________	1 ^{08}

10. In general terms, how would you rate the form of coordination you checked in Question 9 for your school's secondary science program?

Excellent	19 ^{1}
Very good	39 ^{2}
Satisfactory	36 ^{3}
Unsatisfactory	5 ^{4}
Very unsatisfactory	1 ^{5}

11. Now, think about your DISTRICT's secondary science program. Which ONE of the following best describes the form of coordination which exists at the district level?

There is a specially designated science coordinator, supervisor or consultant responsible for just the secondary grades.	10	1
There is a specially designated science coordinator, supervisor or consultant who is responsible for elementary and secondary grades.	8	2
There is a specially designated coordinator, supervisor or consultant who is responsible for science and one or more other subjects.	15	3
Coordination is performed by a working group of teachers in the district.	16	4
Coordination has been assumed informally by one of the administrators or teachers in the district.	4	5
There is no particular form of coordination.	43	6
Other (specify): ______________________________	4	7

12. In general terms, how would you rate the form of coordination you checked in Question 11 for your district's secondary science program?

Excellent	4	1
Very good	7	2
Satisfactory	44	3
Unsatisfactory	36	4
Very unsatisfactory	10	5

C. PHYSICAL FACILITIES, MATERIALS AND EQUIPMENT

13. How adequate is each of the following in your school for the purposes of teaching science?

	Facility is:				
	Not Required	Needed But Not Available	Very Inadequate	Somewhat Inadequate	Adequate or Better
1. Lighting	0	0	2	12	86
2. Storage space for science materials/ equipment	0	1	13	33	53
3. Storage space for microscope slides	7	0	7	22	65
4. Storage space for volatiles	1	3	15	31	50
5. Storage space for student projects.	7	7	31	35	21
6. Science preparation room	2	5	14	27	52
7. Water outlets . .	0	1	8	18	73
8. Electrical outlets	0	0	7	18	75
9. Gas outlets . . .	1	2	4	13	81
10. Sinks or drainage facilities . . .	0	1	7	18	74
11. Flat-topped desks or tables . . .	0	1	4	13	82
12. Safety equipment .	0	1	6	30	63
13. Amount of work space per student	0	1	7	31	61
14. Audio-visual equipment	0	0	4	20	75
15. Fume hood/closet .	5	7	9	20	59
16. Ventilation . . .	1	3	17	32	48
17. Chalkboard space .	0	0	4	19	77
18. Bulletin board space	0	1	7	27	65
19. Microcomputers . .	24	17	19	19	21

14. How systematically is the safety equipment in your science area/room/laboratory checked?

There is no safety equipment.	2^{1}
Casually; no systematic check	43^{2}
Systematically; once a year	36^{3}
Systematically; more than once a year	19^{4}

15. What safety equipment do you have in your science teaching area/room/laboratory? (*Check all that apply*)

1. I have no safety equipment	1^{1}
2. Fire blankets	72^{1}
3. Fire extinguisher	94^{1}
4. Master gas shut-off	90^{1}
5. Master water shut-off	29^{1}
6. Approved first aid kit	60^{1}
7. Safety goggles	76^{1}
8. Asbestos gloves	25^{1}
9. Sand buckets and scoops	11^{1}
10. Eye-wash stations	79^{1}
11. Acid spill clean-up kit	12^{1}
12. Safety charts	43^{1}
13. Demonstration safety shield	18^{1}
14. Other (specify) ________________	5^{1}

16. Apart from minor changes, how often in the past year have you had to adapt your teaching plans because of difficulty in obtaining the necessary science equipment?

Never	17^{1}
Seldom, about once or twice	54^{2}
Fairly often, about three or four times	16^{3}
Quite often, about five or six times	6^{4}
Far too often, more than six times	6^{5}
I seldom plan to use equipment.	1^{6}

17. Overall, how do you rate the QUALITY of the science materials/ equipment available to you?

Excellent	17	1
Very good	41	2
Satisfactory	37	3
Unsatisfactory	5	4
Very unsatisfactory	1	5

18. How much input do you have in deciding what science materials/ equipment are to be purchased in your school?

Virtually none	2	1
Some, but not enough	11	2
Some, about right	82	3
Too much, I do it all	5	4

19. Who maintains and accounts for the science materials/equipment in your school?

Each teacher of science looks after his/her own.	19	1
Each teacher of science looks after certain materials/ equipment.	18	2
A specially designated teacher looks after it all.	5	3
Head of science department looks after it all.	34	4
Paid assistants look after it all.	15	5
There is no policy on who is responsible.	5	6
Other (specify): ____________	4	7

20. What is the most frequent way for you to get your science materials/ equipment?

Through a central source in the DISTRICT	28	1
Through a central source in the SCHOOL	49	2
Through a sharing arrangement between schools	0	3
I get my own.	18	4
Other (specify): ____________	4	5

21. How difficult is it to obtain science materials/equipment when you need it?

Not difficult at all	30 ^{1}
Not very difficult	46 ^{2}
Somewhat difficult	21 ^{3}
Very difficult	3 ^{4}

22. In your opinion, how adequate are the science reading materials in your school?

Very inadequate	13 ^{1}
Somewhat inadequate	33 ^{2}
Satisfactory	45 ^{3}
More than adequate	9 ^{4}

23. How often do you use the following audio visual aids when teaching science?

	Not Available	Never	Occasionally (1 - 5 Times/Unit)	Frequently (More than 5 Times/Unit)
1. Overhead	1 ^{0}	8 ^{1}	41 ^{2}	50 ^{3}
2. Large charts	2 ^{0}	8	65 ^{2}	25 ^{3}
3. Models	3 ^{0}	6 ^{1}	75 ^{2}	16 ^{3}
4. Films	1 ^{0}	5 ^{1}	68 ^{2}	26 ^{3}
5. Filmstrips	1 ^{0}	25 ^{1}	65 ^{2}	13 ^{3}
6. 35 mm. slides	4 ^{0}	35 ^{1}	55 ^{2}	7 ^{3}
7. Audio tapes	5 ^{0}	57 ^{1}	35 ^{2}	3 ^{3}
8. Video tapes	2 ^{0}	19 ^{1}	64 ^{2}	16 ^{3}
9. Microcomputers	33 ^{0}	53 ^{1}	13 ^{2}	1 ^{3}
10. Other (specify): ____________	3 ^{0}	25 ^{1}	44 ^{2}	28 ^{3}

24. How much money has been allocated to the science program in your school this year?

More than enough to teach the program properly	6 ^{1}	*(go to Question 26)*
Enough to teach the program properly	72 ^{2}	*(go to Question 26)*
Not enough to teach the program properly	13 ^{3}	*(go to Question 25)*
I don't know	10 ^{4}	*(go to Question 26)*

25. If there was not enough money available, how have you coped?

Major program changes were necessary	3 ^{1}
Minor program changes were necessary	70 ^{2}
I coped without making changes	27 ^{3}

D. SCIENCE TEACHING

26. In your opinion, how worthwhile is the prescribed B.C. science program to the students you are presently teaching?

Very worthwhile	29 ^{1}
Of some worth	63 ^{2}
Of little worth	6 ^{3}
Practically worthless	2 ^{4}

27. If you had a choice, at which ONE of the following grade levels, if any, would you prefer to teach science?

I would prefer not to teach science at all.	3 ^{1}
Primary/kindergarten	0 ^{2}
Intermediate	2 ^{3}
Junior secondary	19 ^{4}
Senior secondary	41 ^{5}
Junior-Senior secondary	32 ^{6}
Post-secondary	4 ^{7}

28. In general, how well prepared do you feel for the teaching of science?

Not at all	0 ^{1}
Somewhat	4 ^{2}
Adequately	44 ^{3}
More than adequately	53 ^{4}

29. Which of the following best describes your current teaching assignment?

I teach only science.	50 ^{1}	(*go to Question 31*)
I teach science 50% or more of the time.	31 ^{2}	(*continue to Question 30*)
I teach science between 25% and 50% of the time.	12 ^{3}	
I teach science less than 25% of the time.	7 ^{4}	

30. Besides your science load, which of the following form part of your present assignment? (*Check all that apply*)

Mathematics	61 ^{1}
Physical Education	14 ^{1}
Other subjects	28 ^{1}
Counselling and/or Administration	16 ^{1}

31. How important do you think secondary science should be in a student's schooling?

More important than all other subjects	1 ^{1}
More important than most other subjects	21 ^{2}
Equal to other subjects	77 ^{3}
Less important than most other subjects	1 ^{4}
Less important than all other subjects	0 ^{5}

32. In your opinion, how important do administrators in your school district think secondary science should be in a student's schooling?

More important than all other subjects	0 ^{1}
More important than most other subjects	7 ^{2}
Equal to other subjects	84 ^{3}
Less important than most other subjects	9 ^{4}
Less important than all other subjects	0 ^{5}

33. Have you noticed any change in student interest and motivation in learning science at school over the last four or five years?

I have not taught science that long so cannot answer.	13 [1]
I have not noticed any change.	38 [2]
Motivation seems to have improved	20 [3]
Motivation seems to have decreased	29 [4]

34. Compared to the present, would you like to see more, the same or less of each of the following in your school's SCIENCE PROGRAM?

	Less	Same	More
1. Provision of print materials other than textbooks	1 [1]	23 [2]	76 [3]
2. Integration of science with other subject areas	4 [1]	47 [2]	49 [3]
3. Discovery learning	24 [1]	57 [2]	19 [3]
4. Activity-centred learning	6 [1]	66 [2]	28 [3]
5. Alternate programs in science	4 [1]	31 [2]	65 [3]
6. Locally developed programs	7 [1]	53 [2]	40 [3]
7. Outdoor education	8 [1]	51 [2]	42 [3]
8. Teaching of basic science concepts	0 [1]	63 [2]	37 [3]
9. Teaching of science processes (e.g., classifying, controlling variables, measuring)	3 [1]	65 [2]	31 [3]
10. Definition of core curriculum	9 [1]	61 [2]	30 [3]
11. Background information for teachers	1 [1]	31 [2]	68 [3]
12. Provincial learning assessment	19 [1]	66 [2]	15 [3]
13. District learning assessment	16 [1]	65 [2]	19 [3]
14. Freedom for teacher to define course	12 [1]	64 [2]	23 [3]
15. Teacher input into purchase of equipment . .	0 [1]	75 [2]	25 [3]
16. Environmental education	5 [1]	52 [2]	44 [3]
17. Field trips	2 [1]	57 [2]	41 [3]
18. Provisions for meeting the needs of gifted children	0 [1]	26 [2]	74 [3]
19. Provisions for meeting the needs of handicapped children	4 [1]	45 [2]	51 [3]
20. Specialist science teachers in elementary schools	4 [1]	35 [2]	61 [3]
21. Emphasis on the impact of science on society	2 [1]	31 [2]	68 [3]

35. Which of the following special science programs exist in your school? (*Check all that apply*)

1. Modified science courses for students leaving school during junior high school years and for low achievers	61 ^{1}
2. Special learning assistance for low achievers	63 ^{1}
3. Technology-oriented science courses (*e.g., forestry, mining, etc.*)	22 ^{1}
4. Recreation science courses (*either courses or extra-curricular clubs - lapidary, science photography, nature study*)	21 ^{1}
5. Special electives or sections for advanced students	17 ^{1}
6. Other (specify): ____________________	10 ^{1}

E. TEACHER EDUCATION

36. How adequately did your pre-service teacher education program prepare you for teaching secondary science?

Very inadequately	19 ^{1}
Somewhat inadequately	34 ^{2}
Adequately	39 ^{3}
More than adequately	8 ^{4}

37. How much emphasis do you feel SHOULD be placed on each of the following in preparing student teachers to teach science?

	Very Little Emphasis	Some Emphasis	Moderate Emphasis	Heavy Emphasis
1. Techniques of teaching science .	0 ^{1}	7 ^{2}	33 ^{3}	61 ^{4}
2. Techniques for developing reading skills in science . . .	4 ^{1}	30 ^{2}	44 ^{3}	23 ^{4}
3. Techniques for developing writing skills in science . . .	3 ^{1}	30 ^{2}	46 ^{3}	22 ^{4}
4. Subject matter in specific areas of science	6 ^{1}	16 ^{2}	37 ^{3}	41 ^{4}
5. General science	3 ^{1}	22 ^{2}	48 ^{3}	28 ^{4}
6. History & philosophy of science	23 ^{1}	48 ^{2}	22 ^{3}	6 ^{4}
7. Psychology of learning	13 ^{1}	36 ^{2}	37 ^{3}	13 ^{4}
8. Testing/evaluating/grading in science	1 ^{1}	22 ^{2}	56 ^{3}	21 ^{4}
9. Psychology of adolescence . . .	12 ^{1}	39 ^{2}	33 ^{3}	15 ^{4}
10. Theories of intellectual development	26 ^{1}	42 ^{2}	25 ^{3}	7 ^{4}
11. Survey of available curriculum materials	4 ^{1}	32 ^{2}	41 ^{3}	24 ^{4}
12. How to develop curriculum materials	5 ^{1}	29 ^{2}	38 ^{3}	28 ^{4}
13. Lesson planning	2 ^{1}	15 ^{2}	44 ^{3}	39 ^{4}
14. Preparation of science materials	0 ^{1}	18 ^{2}	48 ^{3}	34 ^{4}
15. Practice in teaching science . .	0 ^{1}	3 ^{2}	21 ^{3}	76 ^{4}
16. Discussion of problems of science teaching	2 ^{1}	19 ^{2}	41 ^{3}	38 ^{4}
17. Care and maintenance of animals in the classroom	20 ^{1}	49 ^{2}	26 ^{3}	6 ^{4}
18. Care and maintenance of equipment	7 ^{1}	42 ^{2}	39 ^{3}	12 ^{4}
19. Laboratory safety	1 ^{1}	17 ^{2}	39 ^{3}	43 ^{4}
20. Special education	15 ^{1}	50 ^{2}	29 ^{3}	5 ^{4}
21. Integration with other subjects.	12 ^{1}	46 ^{2}	33 ^{3}	9 ^{4}
22. Use of community resources . . .	5 ^{1}	45 ^{2}	42 ^{3}	8 ^{4}
23. Use of audio-visual materials .	4 ^{1}	30 ^{2}	51 ^{3}	15 ^{4}
24. Other (specify): ____________	6 ^{1}	11 ^{2}	16 ^{3}	68 ^{4}

38. How much emphasis WAS placed on each of the following in your pre-service preparation period for the teaching of science?

	Very Little Emphasis	Some Emphasis	Moderate Emphasis	Heavy Emphasis
1. Techniques of teaching science .	14[1]	37[2]	39[3]	11[4]
2. Techniques for developing reading skills in science . . .	79[1]	14[2]	7[3]	1[4]
3. Techniques for developing writing skills in science . . .	78[1]	15[2]	6[3]	1[4]
4. Subject matter in specific areas of science	18[1]	26[2]	30[3]	26[4]
5. General science	21[1]	37[2]	34[3]	9[4]
6. History & philosophy of science.	59[1]	29[2]	9[3]	3[4]
7. Psychology of learning	17[1]	37[2]	35[3]	12[4]
8. Testing/evaluating/grading in science	21[1]	41[2]	32[3]	7[4]
9. Psychology of adolescence . . .	31[1]	34[2]	28[3]	8[4]
10. Theories of intellectual development	40[1]	35[2]	20[3]	6[4]
11. Survey of available curriculum materials	38[1]	41[2]	17[3]	4[4]
12. How to develop curriculum materials	53[1]	29[2]	15[3]	4[4]
13. Lesson planning	9[1]	31[2]	40[3]	20[4]
14. Preparation of science materials	30[1]	42[2]	23[3]	5[4]
15. Practice in teaching science . .	7[1]	24[2]	46[3]	23[4]
16. Discussion of problems of science teaching	36[1]	43[2]	17[3]	4[4]
17. Care and maintenance of animals in the classroom	84[1]	13[2]	3[3]	1[4]
18. Care & maintenance of equipment	76[1]	18[2]	4[3]	2[4]
19. Laboratory safety	56[1]	33[2]	9[3]	3[4]
20. Special education	89[1]	9[2]	2[3]	0[4]
21. Integration with other subjects.	81[1]	14[2]	4[3]	1[4]
22. Use of community resources . . .	69[1]	23[2]	7[3]	1[4]
23. Use of audio-visual materials .	30[1]	40[2]	26[3]	4[4]
24. Other (specify): ____________	58[1]	8[2]	8[3]	25[4]

39. How much in-service education do you feel you require THIS YEAR to do a good job teaching science?

None	29
3 - 5 hours (one afternoon workshop)	24
Several sessions of 3 - 5 hours	42
An intensive refresher course	6

40. Based on your previous experience, indicate the value of each of the following for your teaching.

	Have Not Experienced	Have Experienced Little Value	Moderate Value	Much Value
1. Informal meetings with other science teachers	1	8	42	49
2. Informal meetings with university science education instructors . .	31	27	32	11
3. Informal meetings with scientists.	44	16	27	13
4. Workshops presented by other teachers	8	12	54	26
5. Workshops presented by university science educators	17	27	43	14
6. Workshops presented by a district resource person	35	20	37	8
7. Workshops presented by scientists.	43	14	27	15
8. Workshops presented by Ministry of Education officials	56	22	18	4
9. University credit courses in science content	16	11	39	35
10. University credit courses in science methods	21	25	42	12
11. Visits to other classrooms	18	12	45	24
12. Annual conferences for science teachers	18	9	38	36
13. Other (specify): ______________ ______________________________	11	0	11	79

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41. How effective are the science in-service education activities which are provided in your school/district?

No in-service activities specifically provided for science . .	38^{0}
Very ineffective	9^{1}
Somewhat ineffective	24^{2}
Fairly effective	27^{3}
Very effective	2^{4}

42. Generally, how willing would you be to participate in a science in-service education workshop after school hours (*first column*) or on weekends (*second column*)?

	1. After School Hours	2. On Week-ends
Definitely would not participate	5^{1}	13^{1}
Probably would not participate	11^{2}	23^{2}
Probably would participate	56^{3}	44^{3}
Definitely would participate	27^{4}	20^{4}

43. Generally, how willing would you be to participate in an in-service education workshop in science during school hours IF RELEASE TIME WERE GIVEN?

Definitely would not participate	3^{1}
Probably would not participate	3^{2}
Probably would participate	36^{3}
Definitely would participate	58^{4}

F. ASSESSMENT AND TESTING

44. Have you read the following publications concerning the B.C. Science Assessment (1978)?

	Yes	No
1. Your District's Interpretation Report	43 [1]	57 [2]
2. Provincial Summary Report	50 [1]	49 [2]
3. Provincial General Report, Volume 1 (*student surveys*)	23 [1]	77 [2]
4. Provincial General Report, Volume 2 (*teacher surveys*)	24 [1]	75 [2]

45. In your school, what impact have the results and recommendations from the previous B.C. Science Assessment had on each of the following?

	None	Minimal	Significant	I don't know
1. Allocation of personnel	42 [1]	12 [2]	2 [3]	45 [4]
2. Provision of in-service	36 [1]	19 [2]	2 [3]	43 [4]
3. Change in curriculum emphasis	27 [1]	23 [2]	12 [3]	38 [4]
4. Change in evaluation practices	35 [1]	22 [2]	4 [3]	39 [4]
5. Provision of supplementary materials	32 [1]	24 [2]	3 [3]	41 [4]
6. Provision for special needs students	31 [1]	21 [2]	7 [3]	41 [4]
7. Improvement of instructional practices . .	21 [1]	23 [2]	4 [3]	42 [4]
8. Increase in time scheduled for science instruction . . .	49 [1]	12 [2]	3 [3]	36 [4]
9. Your own teaching	29 [1]	35 [2]	8 [3]	29 [4]

G. GRADE-SPECIFIC INFORMATION

Questions in the remainder of the questionnaire are meaningful only if answered with a specific science class in mind. This class will be identified by answering the following question.

46. Please identify the ONE class with which you have had both RECENT and EXTENSIVE experience in the teaching of science. If this is not possible, choose the class with which you have had the most RECENT experience. Note that all of the remaining questions refer to this specific class. Which ONE of the following best describes the class you have selected? *(If there is more than one grade level represented in your class, please select only ONE of those grades, preferably the one with the largest enrolment.)*

Science Grade 8	22 ^{01}	*(go to Question 47)*
Science Grade 9	18 ^{02}	*(go to Question 49)*
Science Grade 10	18 ^{03}	*(go to Question 52)*
Biology 11	9 ^{04}	*(go to Question 57)*
Biology 12	7 ^{05}	*(go to Question 63)*
Chemistry 11	7 ^{06}	*(go to Question 67)*
Chemistry 12	7 ^{07}	*(go to Question 67)*
Physics 11	8 ^{08}	*(go to Question 69)*
Physics 12	3 ^{09}	*(go to Question 69)*
Earth Science 11/Geology 12	1 ^{10}	*(go to Question 72)*

H. JUNIOR SECONDARY PROGRAM

Questions 47 to 56 are to be answered ONLY by teachers who are responding from a Junior Secondary teaching perspective.

47. What is your reaction to the current Grade 8 text, Introducing Science Concepts in the Laboratory, by Schmid/Murphy?

Very satisfied	21 ^{1}
Moderately satisfied	45 ^{2}
Neutral	13 ^{3}
Moderately dissatisfied	15 ^{4}
Very dissatisfied	6 ^{5}

48. About how many hours are usually spent by your Grade 8 class on each of the following sections of the Junior Secondary curriculum?

	Number of Hours/Grade					
	0-9	10-19	20-29	30-39	40-49	50+
Grade 8						
1. Chemistry: The study of matter	0 ^{1}	3 ^{2}	36 ^{3}	42 ^{4}	19 ^{5}	1 ^{6}
2. Biology: Living things detect and respond to stimuli	1 ^{1}	8 ^{2}	45 ^{3}	30 ^{4}	14 ^{5}	3 ^{6}
3. Earth Science: The earth's changing surface	10 ^{1}	18 ^{2}	28 ^{3}	23 ^{4}	11 ^{5}	1 ^{6}
4. Physics: Light	1 ^{1}	11 ^{2}	41 ^{3}	32 ^{4}	14 ^{5}	1 ^{6}

Grade 8 teachers - now skip to Question 54

49. How does the revised Grade 9 science text, Developing Science Concepts in the Laboratory (2nd Ed.), by Schmid/Murphy compare with the previous edition by Schmid et al?

It is considerably better	70 ^{1}
It is somewhat better	17 ^{2}
It is much the same	3 ^{3}
It is not as good	0 ^{4}
It is considerably worse	3 ^{5}
Not familiar with the earlier edition	7 ^{6}

50. How many of the practical application suggestions in the revised Grade 9 science text by Schmid/Murphy do you use?

Almost all	22 ^{1}
About half	49 ^{2}
Very few	24 ^{3}
None	6 ^{4}

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51. About how many hours are usually spent by your Grade 9 class on each of the following sections of the Junior Secondary curriculum?

	Number of Hours/Grade					
	0-9	10-19	20-29	30-39	40-49	50+
Grade 9						
1. Energy	2 ^{1}	9 ^{2}	28 ^{3}	39 ^{4}	17 ^{5}	6 ^{6}
2. Astronomy: The Science of space	13 ^{1}	25 ^{2}	35 ^{3}	18 ^{4}	7 ^{5}	2 ^{6}
3. Matter, Energy and chemical changes	0 ^{1}	4 ^{2}	32 ^{3}	41 ^{4}	19 ^{5}	3 ^{6}
4. Energy and Living Organisms	0 ^{1}	7 ^{2}	35 ^{3}	35 ^{4}	17 ^{5}	5 ^{6}

Grade 9 teachers - now go to Question 54

52. How useful do you find each of the following materials?

	Cannot Say	Of Little Use	Useful	Very Useful
1. Labtext in Science (Cannon *et al*)	44 ^{1}	41 ^{2}	13 ^{3}	2 ^{4}
2. Mixtures in Chemistry (Harrison, Murphy)	41 ^{1}	40 ^{2}	14 ^{3}	4 ^{4}
3. Ecology: Field Research in Science (Jacobson *et al*) . . .	52 ^{1}	41 ^{2}	5 ^{3}	2 ^{4}
4. Investigations in Science Modules (Wiley Series)	75 ^{1}	18 ^{2}	6 ^{3}	1 ^{4}
5. Extending Concepts in the Laboratory (Rasmussen & Schmidt)	5 ^{1}	35 ^{2}	50 ^{3}	11 ^{4}

53. About how many hours are usually spent by your Grade 10 class on each of the following sections of the Junior Secondary curriculum?

	Number of Hours/Grade					
	0-9	10-19	20-29	30-39	40-49	50+
Grade 10						
1. Radioactivity	95 ^{1}	3 ^{2}	2 ^{3}	0 ^{4}	0 ^{5}	0 ^{6}
2. Electricity and magnetism	3 ^{1}	19 ^{2}	53 ^{3}	19 ^{4}	5 ^{5}	1 ^{6}
3. Atoms, Molecules and Ions	1 ^{1}	14 ^{2}	46 ^{3}	28 ^{4}	8 ^{5}	3 ^{6}
4. The Planet Earth (Earth Science) . . .	36 ^{1}	26 ^{2}	31 ^{3}	5 ^{4}	1 ^{5}	1 ^{6}
5. Cells Reproduction and Heredity	1 ^{1}	9 ^{2}	24 ^{3}	35 ^{4}	20 ^{5}	10 ^{6}
6. Sound and Wave Motion .	53 ^{1}	32 ^{2}	13 ^{3}	2 ^{4}	1 ^{5}	0 ^{6}

54. How do you usually use the Reading About Science series by Anastasiou *et al*? (*Check one only*)

Never use it	31 ^{1}
Make it available to students to read as they wish	9 ^{2}
Recommend certain readings without follow-up	14 ^{3}
Assign readings to discuss in class	34 ^{4}
Assign readings to test in class	13 ^{5}

55. For each of the following characteristics, how suitable are the background reading materials for the Reading About Science series?

1. Too difficult	52 [1]
About the right difficulty	40 [2]
Too easy	2 [3]
I don't know	7 [4]
2. Up-to-date	8 [1]
Partly up-to-date	59 [2]
Out-of-date	27 [3]
I don't know	6 [4]
3. Not relevant to lab topics	54 [1]
Relevant to lab topics	39 [2]
I don't know	6 [3]
4. Generally satisfactory	34 [1]
Generally unsatisfactory	59 [2]
I don't know	7 [3]

56. How useful do you find each of the following materials for your grade level?

	Cannot Say	Of Little Use	Useful	Very Useful
1. B.C.T.F. Lesson Aids	39 [1]	26 [2]	32 [3]	4 [4]
2. Locally developed units	50 [1]	17 [2]	24 [3]	10 [4]
3. Searching for Structure Series (James *et al*)	91 [1]	7 [2]	2 [3]	0 [4]
4. Intermediate Science Curriculum Study (ISCS)	76 [1]	12 [2]	11 [3]	0 [4]
5. Independent Investigations in Science (IIS) (Wong *et al*)	86 [1]	9 [2]	5 [3]	1 [4]
6. Canadian Cancer Society Package	71 [1]	11 [2]	15 [3]	2 [4]
7. Other (specify): ______	44 [1]	3 [2]	28 [3]	25 [4]

PLEASE NOW SKIP TO QUESTION 77 ON PAGE 34. Section I is only for those responding from a Senior Secondary point of view.

58. Rate the following course materials in terms of their suitability for Biology 11.

	Unsuitable	Suitable	Very Suitable	Don't Know
1. B.S.C.S. Biological Science: An Ecological Approach (green version)	41[1]	50[2]	9[3]	0[4]
2. B.S.C.S. Biological Science: An Inquiry into Life Lab Text (yellow version)	21[1]	52[2]	21[3]	6[4]
3. B.S.C.S. Biological Science: Molecules to Men (blue version)	25[1]	28[2]	5[3]	43[4]
4. Laboratory and Field Investigations (Miller and Vance) . . .	27[1]	47[2]	2[3]	25[4]
5. Laboratory Manual Biological Science (Gregory)	21[1]	54[2]	18[3]	7[4]
6. Laboratory Outlines in Biology (Abramoff and Thomson)	15[1]	61[2]	21[3]	3[4]
7. B.C. Curriculum Guide for Biology 11	31[1]	50[2]	11[3]	8[4]
8. Animals Without Backbones (Buchsbaum)	3[1]	15[2]	82[3]	0[4]
9. Resource Book of Test Items . . .	15[1]	36[2]	16[3]	33[4]
10. Student Lab Outline (Ministry of Education)	45[1]	34[2]	3[3]	18[4]
11. A Guide to the Study of Freshwater Biology (Needham and Needham) . .	19[1]	57[2]	22[3]	3[4]
12. Trees, Shrubs and Flowers to Know in B.C. (Lyons)	13[1]	64[2]	22[3]	0[4]
13. B.S.C.S. Lab Blocks: (1) Field Ecology (2) Life in the Soil	29[1]	56[2]	5[3]	11[4]
14. Botany: An Introduction to Plant Biology (Weier et al) . . .	25[1]	43[2]	14[3]	14[4]
15. Canadian Cancer Society Package .	13[1]	48[2]	17[3]	22[4]

59. Approximately how much time is spent in Biology 11 on each of the following?

	10 Hours Or Fewer	20 Hours	30 Hours	40 Hours	50 Hours or more
1. Ecology	22^{1}	24^{2}	27^{3}	27^{4}	0^{5}
2. Diversity	6^{1}	3^{2}	13^{3}	27^{4}	51^{5}
3. Evolution	58^{1}	26^{2}	12^{3}	0^{4}	5^{5}
4. Optional material .	46^{1}	40^{2}	9^{3}	2^{4}	4^{5}

60. Should there be more, less or about the same amount of human biology in Biology 11 as at present?

More than at present	61^{1}
About the same	39^{2}
Less than at present	0^{3}

61. Do you feel that an alternative course, concentrating on human biology, should be developed for the Grade 11 level?

Yes	78^{1}
No	18^{2}
Not sure	4^{3}

62. Would you teach such a course if it were an option?

Yes	88^{1}
No	3^{2}
Not sure	9^{3}

IF YOU HAVE ANY COMMENTS REGARDING CHANGES YOU WOULD LIKE MADE TO THE BIOLOGY 11 PROGRAM, PLEASE USE THE SPACE PROVIDED ON THE LAST PAGE.

Biology 11 teachers - now go to Question 74.

Questions 63 to 66 are only to be answered by those responding from a Biology point of view.

63. How frequently do you use the following materials for Biology 12?

	Never	Occasionally	Regularly
1. Investigations of Cells and Organisms, A Laboratory Study in Biology - (Abramoff, Thomson) .	10 [1]	48 [2]	42 [3]
2. Foundations of Biology (McElroy et al)	0 [1]	16 [2]	84 [3]
3. B.C. Curriculum Guide for Biology 12	24 [1]	34 [2]	42 [3]
4. Botany: An Introduction to Plant Biology (Weier et al)	13 [1]	54 [2]	33 [3]
5. Other sources of materials	0 [1]	38 [2]	62 [3]

64. Rate the following course materials in terms of their suitability for Biology 12.

	Unsuitable	Suitable	Very Suitable	Don't Know
1. Investigations of Cells and Organisms: A Laboratory Study in Biology (Abramoff, Thomson) .	40 [1]	44 [2]	16 [3]	0 [4]
2. Foundations in Biology (McElroy et al)	42 [1]	40 [2]	17 [3]	2 [4]
3. Botany: An Introduction to Plant Biology (Weier et al)	23 [1]	48 [2]	29 [3]	0 [4]
4. Workbook of Investigations of Cells and Organisms	61 [1]	30 [2]	7 [3]	2 [4]
5. Dissection of the Fetal Pig . . .	4 [1]	29 [2]	67 [3]	0 [4]
6. Dissection Guide for the Fetal Pig	4 [1]	33 [2]	63 [3]	0 [4]
7. Other sources of materials	0 [1]	4 [2]	83 [3]	9 [4]

65. Approximately how much time is spent in Biology 12 on each of the following?

	10 Hours Or Fewer	20 Hours	30 Hours	40 Hours	50 Hours or more
1. Physiology	0 [1]	0 [2]	4 [3]	22 [4]	74 [5]
2. Cellular Biology . .	4 [1]	22 [2]	39 [3]	29 [4]	6 [5]
3. Evolution	40 [1]	8 [2]	2 [3]	0 [4]	0 [5]
4. Optional material .	71 [1]	61 [2]	13 [3]	0 [4]	0 [5]

66. Would you say that Biology 12 contains too much content, too much process or an appropriate balance of both?

Too much content . . . . 52 [1]

Too much process . . . . 2 [2]

An appropriate balance . . . . 46 [3]

IF YOU HAVE ANY COMMENTS REGARDING CHANGES YOU WOULD LIKE MADE TO THE BIOLOGY 12 PROGRAM PLEASE USE THE SPACE PROVIDED ON THE LAST PAGE.

Biology 12 teachers - now go to Question 74

Questions 67 and 68 are only to be answered by those responding from a Chemistry 11 or a Chemistry 12 point of view.

67. How often are the following used in Chemistry 11?

	Never	Occasionally	Regularly
1. The Nature of Matter (McDonald, Courneya)	53[1]	35[2]	12[3]
2. Inquiries in Chemistry (Turner, Sears)	5[1]	34[2]	61[3]
3. Keys to Chemistry - text (Ledbetter, Young)	54[1]	28[2]	18[3]
4. Keys to Chemistry - lab manual (Ledbetter, Young)	52[1]	29[2]	19[3]
5. Keys to Organic Chemistry (Addison Wesley)	59[1]	35[2]	6[3]
6. Foundations of Chemistry (Toon, Ellis)	45[1]	41[2]	14[3]

68. How often are the following used in Chemistry 12?

	Never	Occasionally	Regularly
1. Foundations of Chemistry (Toon, Ellis)	0[1]	7[2]	93[3]
2. Laboratory Experiments for Foundations of Chemistry (Toon, Ellis)	6[1]	25[2]	69[3]
3. Proton Chemistry (Richardson)	48[1]	34[2]	19[3]
4. Inquiries in Chemistry (Turner, Sears)	54[1]	33[2]	12[3]

IF YOU HAVE ANY COMMENTS ON THE STRENGTHS AND/OR WEAKNESSES OF THE NEW CHEMISTRY 11 AND 12 COURSES, PLEASE USE THE SPACE PROVIDED ON THE LAST PAGE.

Chemistry 11 and 12 teachers - please now skip to Question 74 on page 33.

Questions 69 to 71 are only to be answered by those responding from a Physics 11 or 12 point of view.

69. How often do students use the following books in Physics 11?

	Never	Occasionally	Regularly
1. Fundamentals of Physics (MacNaughton, Martindale)	6 [1]	5 [2]	88 [3]
2. The Ideas of Physics (Giancoli)	16 [1]	62 [2]	21 [3]
3. Laboratory Course in Physics Revised (Livesey *et al*)	61 [1]	23 [2]	16 [3]
4. PSSC Physics, 2nd Edition	57 [1]	28 [2]	15 [3]

70. Rate your impression of the NEW PHYSICS 11 COURSE as compared to the previous Physics 11 course.

Much improved	44 [1]
Slightly improved	34 [2]
About the same in quality	7 [3]
Slightly worse	7 [4]
Much worse	1 [5]
I am not familiar with both courses	6 [6]

71. How often do students use the following books in Physics 12?

	Never	Occasionally	Regularly
1. A Laboratory Course in Physics - Revised (Livesey *et al*)	13 [1]	21 [2]	66 [3]
2. Physical Science Study Committee (PSSC) Physics, 2nd Edition	12 [1]	38 [2]	51 [3]

IF YOU HAVE ANY COMMENTS ON THE STRENGTHS AND/OR WEAKNESSES OF THE PHYSICS 11 AND 12 COURSES, PLEASE USE THE SPACE PROVIDED ON THE LAST PAGE.

Physics 11 and 12 teachers - now skip to Question 74.

Questions 72 and 73 are only to be answered by those responding from an Earth Science or Geology point of view.

72. How often do students use the following books in Earth Science 11?

	Never	Occasionally	Regularly
1. *Foundations of Space Science* (Krynowsky *et al*)	50 [1]	50 [2]	0 [3]
2. *Earth and Space Science; 2nd Ed.* (Wolf *et al*)	22 [1]	67 [2]	11 [3]
3. *Investigating the Earth* (American Geological Institute)	0 [1]	60 [2]	40 [3]
4. *Earth Science* (Goldthwait)	0 [1]	25 [2]	75 [3]
5. *Spaceship Earth/Earth Sciences* Jackson/Evans)	25 [1]	63 [2]	13 [3]
6. *Challenges to Science, Earth Sciences* (Heller *et al*)	11 [1]	78 [2]	11 [3]
7. *Course on Earth Science - 2nd Ed. (Bishop et al)*	75 [1]	25 [2]	0 [3]
8. Reference Package	43 [1]	43 [2]	14 [3]

73. How often do students use the following books in Geology 12?

	Never	Occasionally	Regularly
1. *Geology and the new Global Tectonics* (James)	0 [1]	43 [2]	57 [3]
2. *Geology* (Long)	0 [1]	100 [2]	0 [3]
3. *Principles of Geology* (Gilluly) . .	20 [1]	60 [2]	20 [3]
4. Laboratory Manuals	17 [1]	17 [2]	67 [3]
5. Student Reference Kit	40 [1]	40 [2]	20 [3]

IF YOU HAVE ANY COMMENTS ON THE EARTH SCIENCE 11 OR GEOLOGY 12 COURSES, PLEASE USE THE SPACE PROVIDED ON THE LAST PAGE.

74. One recommendation arising out of the 1978 Science Assessment was that a general science course should be introduced at the Grade 11 level for some students. Has your school initiated such a course?

Yes, one is in place	5	1
No, but one is planned	4	2
No, one is not planned	90	3

75. Which ONE of the following best describes your views on the introduction of a general science course at the Grade 11 level for some students?

This should be done as soon as possible	14	1
It would be worth a try	45	2
There is no great need for it	25	3
It would be a waste of time and money	16	4
Other (specify): ______	1	5

76. If a general science course were to be introduced at the Grade 11 level, would you teach it?

Yes	45	1
No	21	2
I don't know	34	3

J. INSTRUCTIONAL PRACTICES

77. In terms of the science class you chose in Question 46, how often do you engage your students in each of the following?

	Never	Rarely - (Once or Twice During Year)	Occa-sionally	About Half the Time	Fre-quently	Very Frequently (Almost Every Class Period)
1. Carrying out experiments from a set of instructions .	0^{1}	1^{2}	22^{3}	25^{4}	43^{5}	8^{6}
2. Making up their own experiments .	32^{1}	49^{2}	18^{3}	1^{4}	1^{5}	0^{6}
3. Discussing the possible errors in an experiment that has been completed	1^{1}	5^{2}	39^{3}	11^{4}	39^{5}	5^{6}
4. Listening to teacher's explanations	0^{1}	1^{2}	31^{3}	25^{4}	35^{5}	7^{6}
5. Interacting with the teacher in a mix of questions and explanations .	0^{1}	0^{2}	24^{3}	20^{4}	42^{5}	15^{6}
6. Making a graph from the data students get from an experiment . .	4^{1}	20^{2}	54^{3}	5^{4}	16^{5}	1^{6}
7. Generalizing information to new problem situations . .	1^{1}	12^{2}	49^{3}	9^{4}	26^{5}	3^{6}
8. Making guesses about the results of an experiment .	2^{1}	13^{2}	50^{3}	13^{4}	21^{5}	2^{6}
9. Interpreting or explaining for themselves the results of an experiment	1^{1}	5^{2}	33^{3}	15^{4}	41^{5}	5^{6}
10. Classifying objects or events .	6^{1}	22^{2}	51^{3}	7^{4}	14^{5}	1^{6}
11. Describing/reporting observations in their own words .	0^{1}	4^{2}	27^{3}	15^{4}	44^{5}	10^{6}

77. (Continued)

	Never	Rarely - (Once or Twice During Year)	Occasionally	About Half the Time	Frequently	Very Frequently (Almost Every Class Period)
12. Measuring in an experiment	0^{1}	3^{2}	29^{3}	14^{4}	49^{5}	4^{6}
13. Answering questions from worksheets or textbooks . . .	0^{1}	2^{2}	23^{3}	19^{4}	46^{5}	10^{6}
14. Discussing experiment results with other students	1^{1}	7^{2}	42^{3}	15^{4}	31^{5}	4^{6}
15. Copying notes from blackboard/overhead projector	2^{1}	10^{2}	51^{3}	16^{4}	21^{5}	3^{6}
16. Solving quantitative problems .	4^{1}	16^{2}	46^{3}	12^{4}	19^{5}	4^{6}
17. Memorizing scientific information . . .	4^{1}	13^{2}	56^{3}	12^{4}	15	1^{6}
18. Doing investigations at home . .	20^{1}	53^{2}	26^{3}	1^{4}	1^{5}	0^{6}
19. Reading from textbooks	2^{1}	10	51^{3}	14^{4}	21^{5}	3^{6}
20. Doing library research	7^{1}	42^{2}	48^{3}	1^{4}	1^{5}	0^{6}
21. Going on field trips	30^{1}	50^{2}	20^{3}	0^{4}	0^{5}	0^{6}
22. Discussing science issues and values in society	5^{1}	28^{2}	55^{3}	3^{4}	9^{5}	1^{6}

78. What provisions are made in your SCHOOL for individual differences among students in science? (*Check all that apply*)

1. No special provisions	29	1
2. Continuous progress	5	1
3. Learning assistance classes	49	1
4. Modified and/or enriched programs	51	1
5. Other (specify): ____________	5	1

79. What provisions are made in your CLASS for individual differences among students in science? (*Check all that apply*)

1. No special provisions	56	1
2. Individualized instruction	33	1
3. Achievement grouping within the class	9	1
4. Special interest groups	8	1
5. Other (specify): ____________	7	1

80. How many hours per week, on the average, are you allowed DURING SCHOOL HOURS for preparation and marking for the science class you selected as a reference point?

No time during school hours	7	1
Less than 1 hour	38	2
1 - 2 hours	28	3
3 - 4 hours	23	4
More than 4 hours	5	5

81. How many hours per week, on the average, do you NEED to prepare and mark for this science class?

Less than 1 hour	1	1
1 - 2 hours	21	2
3 - 4 hours	33	3
5 - 6 hours	24	4
7 - 8 hours	10	5
9 - 10 hours	5	6
More than 10 hours	7	7

82. What proportion of the lab/experiment write-ups for your class receive detailed comments?

None	4	1
Well below half	32	2
About half	27	3
Well over half	18	4
All	19	5

83. What is the most frequent method of marking lab write-ups for this class in science?

Write-ups are not marked for this class	1	01
A letter grade scale	6	02
Numerical marks	82	03
Satisfactory/unsatisfactory	2	04
Complete/incomplete	2	05
Excellent/fair/poor	4	06
Written comments only	2	07
Other (Specify): ______	1	08

84. On the average, how manageable is your marking load in science?

Usually manageable	35	1
Sometimes manageable, sometimes unmanageable	57	2
Usually unmanageable	8	3

85. How much emphasis do you place on each of the following in deriving a final evaluation for your students in SCIENCE?

	No Emphasis	Little Emphasis	Some Emphasis	Much Emphasis
1. Anecdotal records of achievement	37^{1}	30^{2}	24^{3}	10^{4}
2. Anecdotal records of general attitude in class	34^{1}	36^{2}	28^{3}	3^{4}
3. Anecdotal records of work habits	27^{1}	36^{2}	33^{3}	4^{4}
4. Teacher-made objective tests. .	0^{1}	2^{2}	30^{3}	68^{4}
5. Standardized objective tests. .	50^{1}	22^{2}	22^{3}	7^{4}
6. Subjective tests (essay, paragraph, etc.)	13^{1}	30^{2}	40^{3}	17^{4}
7. Laboratory/experiment write-ups	1^{1}	6^{2}	44^{3}	49^{4}
8. Individual work contracts . . .	70^{1}	19^{2}	9^{3}	2^{4}
9. Reports on topics in science. .	25^{1}	38^{2}	35^{3}	2^{4}
10. Projects	27^{1}	38^{2}	32^{3}	4^{4}
11. Oral tests	64^{1}	24^{2}	11^{3}	1^{4}
12. Student self reports	79^{1}	17^{2}	3^{3}	1^{4}
13. Attendance	45^{1}	30^{2}	20^{3}	5^{4}
14. Other (specify): ____________	39^{1}	10^{2}	35^{3}	17^{4}

86. On the average, what percent of the students in this class do you expect to receive each of the following final letter grades for this course? Total should approximate 100%.

	0-5%	6-15%	16-30%	31-50%	51-100%
1. A (Excellent) .	48^{1}	43^{2}	8^{3}	1^{4}	0^{5}
2. B (Very Good) .	5^{1}	50^{2}	40^{3}	4^{4}	0^{5}
3. C+ (Satis- . . .	1^{1}	12^{2}	51^{3}	33^{4}	3^{5}
4. C factory) . . .	1^{1}	15^{2}	62^{3}	20^{4}	3^{5}
5. P (Pass)	15^{1}	53^{2}	25^{3}	6^{4}	2^{5}
6. F (Fail)	59^{1}	33^{2}	7^{3}	1^{4}	1^{5}

87. In an average week, during this course, how many hours of homework in science do you assign to each student?

0	2[1]
1	26[2]
2	38[3]
3	24[4]
4 or more	10[5]

88. How often do you assign homework in each of the following categories for students in this course?

	Never	Rarely - (Once or Twice During Course)	Occa-sionally	About Half the Time	Fre-quently	Very Frequently (Almost Every Class Period)
1. Problems at the end of a section/chapter	5[1]	9[2]	34[3]	14[4]	34[5]	5[6]
2. Lab/experiment write-ups.	1[1]	4[2]	27[3]	21[4]	40[5]	7[6]
3. Do at home experiments . . .	51[1]	39[2]	10[3]	0[4]	0[5]	0[6]
4. Reading	5[1]	13[2]	49[3]	14[4]	18[5]	1[6]
5. Preparing reports on topics in science	24[1]	42[2]	31[3]	2[4]	2[5]	0[6]
6. Projects	30[1]	42[2]	24[3]	1[4]	2[5]	0[6]
7. Preparing for tests	2[1]	2[2]	56[3]	14[4]	25[5]	2[6]
8. Completing work unfinished in class	1[1]	3[2]	31[3]	19[4]	37[5]	10[6]
9. Completing worksheets	10[1]	12[2]	50[3]	9[4]	18[5]	1[6]
10. Memorizing scientific information . . .	14[1]	27[2]	45[3]	6[4]	7[5]	1[6]
11. Other (specify): ________________	29[1]	6[2]	35[3]	1[4]	18[5]	12[6]

89. How would each of the following changes be likely to affect the quality of science learning in YOUR classroom?

	The quality of learning would likely				
	Deteriorate Seriously	Deteriorate Somewhat	Remain the Same	Improve Somewhat	Improve Greatly
1. More direct input by you into the purchase of equipment	0^{1}	0^{2}	67^{3}	28^{4}	4^{5}
2. Better quality of equipment . .	0^{1}	0^{2}	44^{3}	49^{4}	8^{5}
3. Less responsibility for maintenance of equipment . .	3^{1}	10^{2}	58^{3}	25^{4}	5^{5}
4. Smaller class size . . .	0^{1}	1^{2}	21^{3}	44^{4}	34^{5}
5. Provision of wider selection of printed materials (texts)	0^{1}	1^{2}	20^{3}	55^{4}	25^{5}
6. More coordination at school level .	0^{1}	1^{2}	64^{3}	32^{4}	3^{5}
7. More coordination at district level .	0^{1}	5^{2}	53^{3}	35^{4}	7^{5}
8. Decreased emphasis on core curriculum . . .	4^{1}	20^{2}	55^{3}	19^{4}	3^{5}
9. Increased provision of in-service . .	0^{1}	1^{2}	27^{3}	64^{4}	8^{5}
10. More science books in library . . .	0^{1}	0^{2}	47^{3}	48^{4}	5^{5}
11. More time to prepare and mark.	0^{1}	0^{2}	16^{3}	50^{4}	34^{5}
12. Fewer classes to teach	0^{1}	0^{2}	22^{3}	46^{4}	32^{5}
13. More convenient storage space for equipment . .	0^{1}	0^{2}	52^{3}	39^{4}	9^{5}
14. More university courses in science (taken by yourself) . .	0^{1}	1^{2}	47^{3}	46^{4}	6^{5}

89. (Continued)

	The quality of learning would likely				
	Deteriorate Seriously	Deteriorate Somewhat	Remain the Same	Improve Somewhat	Improve Greatly
15. Higher priority placed on science by administration	0^{1}	0^{2}	55^{3}	42^{4}	3^{5}
16. Less in-service education	3^{1}	46^{2}	50^{3}	1^{4}	0^{5}
17. More time allocated to science.	0^{1}	2^{2}	33^{3}	58^{4}	7^{5}
18. Changes in the new program . . .	1^{1}	3^{2}	42^{3}	44^{4}	10^{5}
19. Increased availability of equipment & materials.	0^{1}	0^{2}	36^{3}	55^{4}	9^{5}
20. Fewer subjects/levels to teach .	0^{1}	2^{2}	34^{3}	46^{4}	18^{5}
21. Increased emphasis on core curriculum .	2^{1}	19^{2}	58^{3}	18^{4}	3^{5}
22. More choice for teacher in selection of program .	1^{1}	4^{2}	50^{3}	39^{4}	7^{5}

90. Do you have enough time to complete the curriculum for this science course?

More than enough time	1^{1}
Enough time	24^{2}
Almost enough time	31^{3}
Not enough time	44^{4}

91. Which time-table pattern does your school have for this course?

Quarter	5^{1}
Semester	34^{2}
Regular full year.	58^{3}
Other (specify): ________________________________	3^{4}

92. Which time-table pattern would you prefer for this course?

Quarter	5 [1]
Semester	23 [2]
Regular full year	71 [3]
Other (specify): ________________	0 [4]

93. How many students are enrolled in the class you have used as a reference for the latter half of this questionnaire?

20 or fewer	15 [1]
21 - 24	23 [2]
25 - 28	36 [3]
29 - 32	22 [4]
33 or more	5 [5]

94. Please use this space to make any other comments on the science program in your school.

APPENDIX J

MALE-FEMALE RESPONSES ON CORRECT OPTION FOR ACHIEVEMENT ITEMS -

TABLE J-1 GRADE 4

Item Number	Percent Correct	
	Male	Female
1.1.01 (X01)	89	88
1.1.02 (X17)	44	54
1.1.03 (X25)	77	80
1.1.04 (X28)	84	90
1.1.05 (X29)	89	93
1.1.06 (X36)	93	94
1.1.07 (Y04)	90	89
1.1.08 (Y09)	94	90
1.1.09 (Y15)	84	91
1.1.10 (Y26)	75	79
1.1.11 (Y34)	31	28
1.1.12 (Y35)	76	80
1.1.13 (Z04)	73	71
1.1.14 (Z07)	85	88
1.1.15 (Z08)	56	57
1.1.16 (Z09)	36	28
1.1.17 (Z16)	7-	84
1.1.18 (Z20)	88	94
1.2.01 (X05)	51	51
1.2.02 (X06)	85	84
1.2.03 (X07)	60	61
1.2.04 (X09)	52	49
1.2.05 (X19)	69	73
1.2.06 (X31)	69	70
1.2.07 (Y11)	52	52
1.2.08 (Y18)	79	81
1.2.09 (Y19)	57	62
1.2.10 (Y25)	41	44
1.2.11 (Y27)	75	74
1.2.12 (Y33)	92	86
1.2.13 (Z10)	56	59
1.2.14 (Z13)	87	89
1.2.15 (Z17)	77	75
1.2.16 (Z21)	71	68
1.2.17 (Z26)	38	49
1.2.18 (Z35)	77	81
1.3.01 (X04)	34	35
1.3.02 (X12)	83	86
1.3.03 (X13)	41	42
1.3.04 (X24)	43	34
1.3.05 (X32)	36	45
1.3.06 (X33)	49	42
1.3.07 (Y05)	65	68
1.3.08 (Y06)	73	73
1.3.09 (Y07)	58	58
1.3.10 (Y23)	53	53
1.3.11 (Y29)	37	42
1.3.12 (Y31)	68	67
1.3.13 (Z02)	94	93
1.3.14 (Z03)	86	87
1.3.15 (Z28)	28	31
1.3.16 (Z31)	60	61
1.3.17 (Z32)	84	87
1.3.18 (Z33)	22	22
1.4.01 (X16)	53	44
1.4.02 (X22)	70	62
1.4.03 (Y03)	64	63
1.4.04 (Y13)	66	71
1.4.05 (Z23)	40	44
1.4.06 (Z24)	81	80
2.1.01 (X02)	71	60
2.1.02 (X08)	85	85
2.1.03 (X11)	68	65
2.1.04 (X15)	67	66
2.1.05 (X23)	53	48
2.1.05 (X26)	33	34
2.1.07 (Y08)	49	51
2.1.08 (Y10)	55	42
2.1.09 (Y12)	50	46
2.1.10 (Y14)	53	49
2.1.11 (Y20)	59	57
2.1.12 (Y22)	77	50
2.1.13 (Z05)	63	57
2.1.14 (Z11)	77	75
2.1.15 (Z14)	39	41
2.1.16 (Z29)	58	47
2.1.17 (Z30)	36	31
2.1.18 (Z34)	61	58
2.2.01 (X03)	52	46
2.2.02 (X30)	80	78
2.2.03 (Y02)	87	86
2.2.04 (Y24)	72	66
2.2.05 (Z12)	54	48
2.2.06 (Z19)	71	77
2.3.01 (X14)	37	30
2.3.02 (X20)	45	42
2.3.03 (X35)	82	81
2.3.04 (Y01)	33	40
2.3.05 (Y21)	77	85
2.3.06 (Y32)	87	90

TABLE J-1 (Continued)

Item Number	Percent Correct Male	Female	Item Number	Percent Correct Male	Female
2.3.07 (Z01)	94	96	3.2.01 (X21)	71	66
2.3.08 (Z15)	86	93	3.2.02 (X27)	61	61
2.3.09 (Z25)	71	76	3.2.03 (Y16)	75	84
3.1.01 (X10)	44	54	3.2.04 (Y17)	64	70
3.1.02 (X18)	37	40	3.2.05 (Z06)	88	91
3.1.03 (X34)	89	86	3.2.06 (Z18)	74	76
3.1.04 (Y28)	96	91			
3.1.05 (Y30)	60	63			
3.1.06 (Y36)	52	37			
3.1.07 (Z22)	55	43			
3.1.08 (Z27)	52	55			
3.1.09 (Z36)	49	46			

TABLE J-2 GRADE 8

Item Number	Percent Correct Male	Female	Item Number	Percent Correct Male	Female
1.1.01 (X09)	67	70	1.4.01 (X06)	78	76
1.1.02 (X24)	85	85	1.4.02 (X07)	48	46
1.1.03 (X29)	53	57	1.4.03 (X16)	42	38
1.1.04 (Y27)	55	45	1.4.04 (Y04)	27	33
1.1.05 (Y29)	62	71	1.4.05 (Y05)	54	62
1.1.06 (Y34)	85	81	1.4.06 (Y06)	33	38
1.1.07 (Z10)	37	41	1.4.07 (Z21)	42	45
1.1.08 (Z15)	73	76	1.4.08 (Z30)	36	36
1.1.09 (Z20)	88	89	1.4.09 (Z31)	40	47
1.2.01 (X14)	60	44	2.1.01 (X01)	58	47
1.2.02 (X36)	72	73	2.1.02 (X10)	53	34
1.2.03 (X38)	63	65	2.1.03 (X11)	39	28
1.2.04 (Y11)	75	74	2.1.04 (X15)	18	21
1.2.05 (Y15)	68	69	2.1.05 (X17)	79	62
1.2.06 (Y40)	75	80	2.1.06 (X19)	59	44
1.2.07 (Z05)	72	59	2.1.07 (X21)	41	42
1.2.08 (Z06)	51	41	2.1.08 (X31)	49	39
1.2.09 (Z22)	86	88	2.1.09 (X34)	63	54
1.3.01 (X04)	64	59	2.1.10 (X35)	50	35
1.3.02 (X05)	47	39	2.1.11 (X37)	74	71
1.3.03 (X26)	69	69	2.1.12 (Y01)	84	78
1.3.04 (Y08)	66	64	2.1.13 (Y02)	78	59
1.3.05 (Y22)	79	87	2.1.14 (Y13)	66	72
1.3.06 (Y24)	28	28	2.1.15 (Y18)	42	36
1.3.07 (Z04)	35	29	2.1.16 (Y23)	57	51
1.3.08 (Z19)	63	66	2.1.17 (Y25)	49	35
1.3.09 (Z32)	64	63	2.1.18 (Y26)	83	75

TABLE J-2 (Continued)

Item Number	Percent Correct		Item Number	Percent Correct	
	Male	Female		Male	Female
2.1.19 (Y28)	35	37	2.3.07 (Y14)	73	77
2.1.20 (Y30)	57	54	2.3.08 (Y20)	82	84
2.1.21 (Y33)	70	61	2.3.09 (Z01)	81	83
2.1.22 (Y39)	51	40	2.3.10 (Z13)	56	54
2.1.23 (Z03)	57	40	2.3.11 (Z27)	81	85
2.1.24 (Z11)	64	64	2.3.12 (Z34)	36	33
2.1.25 (Z14)	37	35	3.1.01 (X02)	80	63
2.1.26 (Z16)	72	78	3.1.02 (X13)	41	30
2.1.27 (Z18)	54	45	3.1.03 (X25)	25	25
2.1.28 (Z23)	64	63	3.1.04 (X33)	70	59
2.1.29 (Z26)	58	50	3.1.05 (X40)	37	27
2.1.30 (Z33)	49	53	3.1.06 (Y03)	74	65
2.1.31 (Z35)	66	66	3.1.07 (Y09)	37	29
2.1.32 (Z36)	42	46	3.1.08 (Y12)	40	51
2.1.33 (Z40)	63	56	3.1.09 (Y32)	65	60
2.2.01 (X08)	66	64	3.1.10 (Y37)	51	44
2.2.02 (X12)	53	49	3.1.11 (Z02)	76	64
2.2.03 (X22)	55	51	3.1.12 (Z09)	42	34
2.2.04 (X30)	38	31	3.1.13 (Z24)	61	35
2.2.05 (Y16)	49	39	3.1.14 (Z25)	43	19
2.2.06 (Y31)	66	73	3.1.15 (Z29)	78	78
2.2.07 (Y35)	63	70	3.2.01 (X20)	33	24
2.2.08 (Y36)	43	47	3.2.02 (X23)	47	49
2.2.09 (Z07)	46	42	3.2.03 (X27)	63	54
2.2.10 (Z17)	51	44	3.2.04 (X32)	50	53
2.2.11 (Z28)	49	52	3.2.05 (Y17)	34	38
2.2.12 (Z39)	46	44	3.2.06 (Y19)	39	34
2.3.01 (X03)	76	79	3.2.07 (Y21)	67	82
2.3.02 (X18)	58	59	3.2.08 (Y38)	52	54
2.3.03 (X28)	51	48	3.2.09 (Z08)	60	58
2.3.04 (X39)	78	74	3.2.10 (Z12)	63	73
2.3.05 (Y07)	82	83	3.2.11 (Z37)	33	23
2.3.06 (Y10)	42	29	3.2.12 (Z38)	24	21

TABLE J-3 GRADE 12

Item Number	Percent Correct		Item Number	Percent Correct	
	Male	Female		Male	Female
1.1.01 (X04)	52	60	1.1.06 (Y06)	43	26
1.1.02 (X05)	23	24	1.1.07 (Y08)	61	55
1.1.03 (X14)	69	68	1.1.08 (Y11)	83	78
1.1.04 (X15)	79	80	1.1.09 (Y22)	47	37
1.1.05 (Y05)	46	38	1.1.10 (Y23)	66	58

Item Number	Percent Correct Male	 Female	Item Number	Percent Correct Male	 Female
1.2.01 (X07)	40	45	2.2.02 (X13)	62	76
1.2.02 (X10)	63	68	2.2.03 (X20)	67	67
1.2.03 (X16)	60	57	2.2.04 (X21)	37	38
1.2.04 (X19)	67	70	2.2.05 (Y29)	60	59
1.2.05 (X30)	68	62	2.2.06 (Y34)	69	77
1.2.06 (X33)	52	48	2.3.01 (X03)	70	46
1.2.07 (X35)	48	44	2.3.02 (X12)	80	67
1.2.08 (Y02)	84	87	2.3.03 (X29)	74	44
1.2.09 (Y09)	57	46	2.3.04 (X32)	61	65
1.2.10 (Y14)	33	25	2.3.05 (Y16)	71	63
1.2.11 (Y21)	52	62	2.3.06 (Y17)	27	17
1.2.12 (Y28)	60	65	2.3.07 (Y24)	65	63
2.1.01 (X02)	49	51	2.3.08 (Y35)	53	38
2.1.02 ((X09)	46	37	3.1.01 (X06)	61	58
2.1.03 (X17)	72	62	3.1.02 (X08)	84	91
2.1.04 (X18)	44	64	3.1.03 (Y03)	52	38
2.1.05 (X22)	60	70	3.1.04 (Y15)	49	53
2.1.06 (X23)	37	32	3.1.05 (Y26)	60	45
2.1.07 (X26)	52	59	3.1.06 (Y31)	69	44
2.1.08 (X27)	53	48	3.2.01 (X11)	51	45
2.1.09 (X31)	60	34	3.2.02 (X24)	54	47
2.1.10 (Y01)	46	44	3.2.03 (X25)	69	46
2.1.11 (Y04)	70	62	3.2.04 (X28)	47	47
2.1.12 (Y07)	78	71	3.2.05 (X34)	41	19
2.1.13 (Y18)	71	57	3.2.06 (Y10)	49	52
2.1.14 (Y20)	52	50	3.2.07 (Y12)	50	32
2.1.15 (Y27)	58	39	3.2.08 (Y13)	42	39
2.1.16 (Y33)	36	25	3.2.09 (Y19)	48	26
2.2.01 (X01)	68	69	3.2.10 (Y25)	36	28
			3.2.11 (Y30)	76	55
			3.2.12 (Y32)	38	34